Get Ready for Jupiter's Comet Crash

ASTRONOMY

April 1994 U.S. $2.95
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Flying Over Martian Volcanos

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Galileo Views Asteroid Ida

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- New Light on the Infrared Universe

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12" LX200
10" LX200
(shown with
optional
Superwedge)
8"
LX200

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8" LX200 Schmidt-Cassegrain	**$2295.**
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12" LX200 Schmidt-Cassegrain	**3995.**
Superwedge 10"/12"	**395.**

Packing & shipping in 48 states: 8"—$105; 10"—$145; 12"—$215.

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- For dealer or catalog information see the **Meade Starfinder Reflecting Telescope** ad in this issue.

LX200 SCHMIDT-CASSEGRAINS:
New Technical Advances for 1994.

Six new technical advances that extend Meade's position at the leading edge of telescope technology:

1. 18-volt Dual-Axis Drive Systems

Systems—All Meade 8", 10", and 12" LX200's now include **18-volt DC power systems,** superseding the previous 12-volt systems, with the result that **LX200 motor torques are increased by about 60%** over previous models. Combined with new, more efficient DC motor electronics, these powerful, high-torque drives, on both telescope axes, yield a level of drive smoothness heretofore unavailable on any commercial telescope.

2. Ultra-reliable Electronic Systems

Systems—Recent electronic refinements in the main circuit boards, the hand controller, and in the control panel electronics have made Meade's new advanced LX200's more reliable than ever before. State-of-the-art improvements in microcircuitry, combined with *thousands* of hours of laboratory and field testing, result in **the most trouble-free serious telescopes ever manufactured.**

3. New *Version 3.20* Software

Software—As recently announced, Meade *Version 3.20* software is the very latest in telescope operating systems and permits **quick (less than 10 seconds!) 2-star alignment** of the LX200 in the altazimuth mode, without requiring your latitude or longitude, without even leveling the tripod. Just use 2 easy-to-find reference stars and the telescope tracks and actuates GO TO with extreme precision.

*For safety reasons AC-powered personal computers should be used indoors only.

Meade 8", 10", and 12" LX200 Schmidt-Cassegrains include an RS-232 serial port (PC connector) on the power panel.

MEADE LX200
COMPUTER DRIVE SYSTEM
LX QUARTZ – DC SERVO MOTOR
SMART DRIVE
Current (mA x 100)
On
Off
N
S
Encoders
RS232
Focuser
Reticle
Keypad
Power 15vDC
CCD
DEC Motor

4. Software Library Options

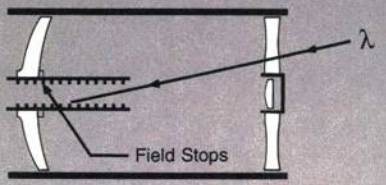
Included with every LX200 is a basic 747-object database of the finest deep-space objects, reference stars, and the 8 major planets. *Version 3.20* LX200 software allows for two new optional object libraries:

—**Library Option 1:** An object database of **10,600** celestial objects taken from the Messier, NGC, and IC catalogs. Available at $99.**

—**Library Option 2:** An object database of **64,350** celestial objects, including the 10,600 objects of Library Option 1, above. Available at $149.**

5. PC-Interface Capability

Meade AstroSearch/200™ sky software permits the interface of a personal computer (PC) to your LX200. Just load Meade AstroSearch/200 software into your PC, connect the PC* to the LX200's PC port (located on the telescope's power panel) and you're ready to **point-and-click on any of 45,000 planetary, deep-space, or stellar objects** now visible on the PC display. As you point-and-click, the LX200 slews at high-speed (up to 8°/second) simultaneously on both axes, precisely centering the object in the field of view. **The Meade AstroSearch/200 celestial software package, supplied on 3.5" discs for Windows™ 3.1 or higher, is available from Meade dealers at $99.95**.**



Field-stops *(arrow),* now included on Meade 8", 10" and 12" Schmidt-Cassegrains, significantly increase image contrast by effectively blocking off-axis stray light rays, λ.

6. Contrast-Enhancing Field Stops

Field Stops—All Meade 8", 10", and 12" Schmidt-Cassegrains now include a series of computer-optimized internal field stops, for greater rejection of unwanted stray light than ever before possible. These field stops, machined into the inside-diameter surface of the primary-mirror baffle tube *(see diagram),* **significantly increase lunar, planetary, and deep-space image contrast,** compared to SCT's not so equipped.

Plus all of the features that have already made Meade® LX200's the largest-selling serious telescopes in the world:

- **Legendary Meade Super Multi-Coated (EMC) Schmidt-Cassegrain Optics** —The finest SC optics available, optics that yield razor-sharp stellar images and high-resolution observing of the Moon, planets, and deep-space.
- **Heavy-Duty Fork Mounts**—The largest, most rigid in the industry, complemented by large 4"-diameter polar ball bearings and by DC servo-motor-driven worm gears on both telescope axes.
- **Four-speed Drives on both Telescope Axes**—Including photo-guiding (at **2x** sidereal rate); image centering and microslewing in the main telescope (at **32x** sidereal rate); image centering in the viewfinder (at **2**°/sec.); or fast-slew of the main telescope across the skies (at up to **8**°/sec.).
- **Digital Readouts**—On both axes, read from the keypad hand controller.
- **GO TO Capability**—Enter the RA and Dec of an object into the keypad hand controller, press GO TO, and the telescope slews to the object at up to 8°/sec., centering it in the field.
- **747-Object Built-in Library**—Enter any of the 110 Messier objects, 278 of the finest NGC objects, 351 stars (doubles, variables, reference stars), or one of the 8 planets (from Mercury to Pluto), press GO TO, and the telescope slews at up to 8°/sec., centering the object in the field.
- **Permanently Programmable Smart Drive™** —Capable of reducing periodic drive errors to 5 arc. secs. or less, an observatory standard.

Specifications: 8", 10", and 12" LX200's—Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 SC optical tube assembly with super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; keypad handheld controller with digital readout display, PPEC Smart Drive, four-speed drive control on both axes, GO TO controller, and 747-object software library; 25 ft. power cord and adapter for telescope operation from 115v.AC (DC capability for operation from auto cigarette lighter plug available optionally); 8 x 50mm viewfinder with crosshairs; 1.25" diagonal prism (8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (8", 10") or giant field tripod (12"); foam-fitted carrying case; complete operating instructions.

ADVANCED PRODUCTS DIVISION
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NASA/JPL, processed by Mark Robinson

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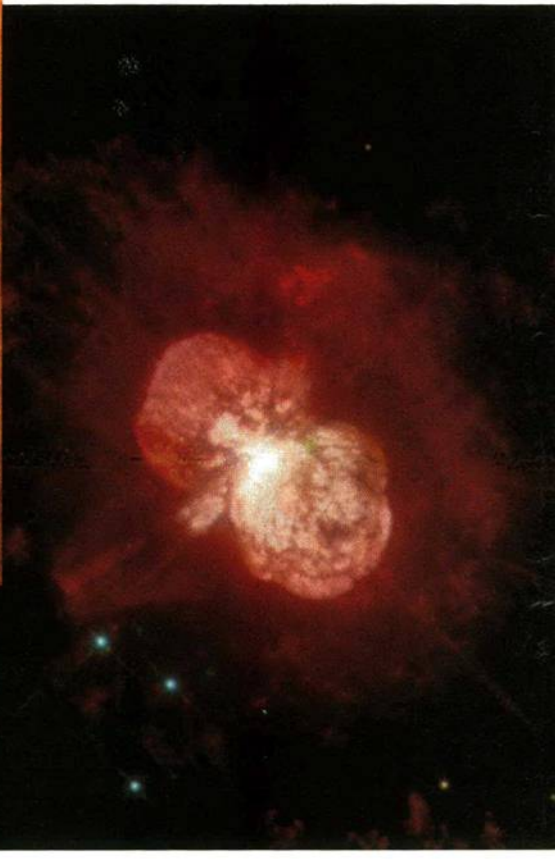
Jeff Hester/Arizona State University and NASA



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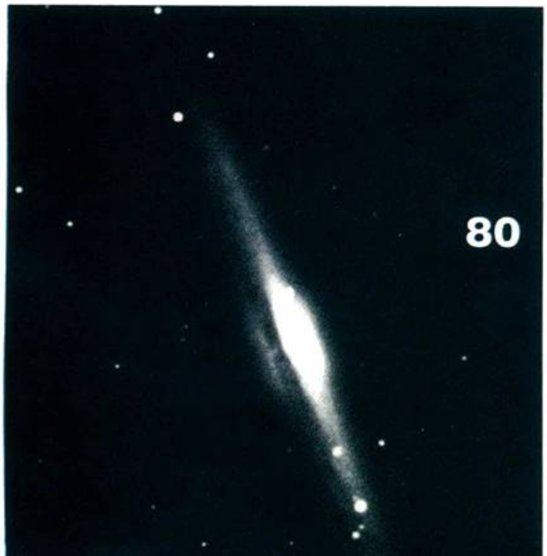

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COVER

STUNNING DETAIL POPS OUT in images from the repaired Hubble Space Telescope. This view of the core of the Virgo cluster galaxy M100, taken with the new Wide Field/Planetary Camera II, resolves detail never seen before. For more Hubble images, see page 44. STScI/NASA photo.

BEHIND THE SCENES

Getting Ready for the Great Comet Crash

When we at ASTRONOMY first heard of the coming collision between Comet Shoemaker-Levy 9 and Jupiter, we immediately realized this event was going to pose a challenge for most backyard telescope owners. Jupiter itself is easy to observe, but at 14th magnitude the comet is faint. Worse, the comet's fragments will strike Jupiter's nightside hemisphere out of sight from Earth.

Just what we'll see is an open question that has even the professionals guessing. If the comet's nuclei turn out to be big, they will explode with a bigger bang. But big nuclei may also dive so deep that Jupiter's atmosphere will muffle the explosions. If the nuclei are small, however, the bursts will occur higher up — yet they'll be smaller and perhaps relatively unspectacular. When the disturbed layers of cloud rotate into view, will the impact effects be obvious or barely visible?

The safest approach is to assume the events will be difficult to observe. As astronomers refined their predictions, we laid out a campaign of coverage for this once-in-a-lifetime event. To kick it off, see page 74, where José Olivarez tells how to view Jupiter, and page 64, where Mark Coco explains how to photograph it. Their advice is important if you want to experience the event to the fullest. Luckily, the comet was discovered more than a year before the impact. This means that planetary scientists can predict the impact times and sites on Jupiter with great accuracy. Such advance notice gives you plenty of time to become familiar with Jupiter's ever-changing appearance *before* the impacts occur.

That familiarity will be critical. "Anyone who buys a telescope two days before the comet hits and thinks he's going to see much is in for a big disappointment," cautioned one Jupiter scientist. Another urged, "For heaven's sake, warn your readers that they need to prepare for this."

It's not just amateur astronomers who are preparing; the pros are too. At one scientific workshop on the comet, I overheard an astronomer exclaim — voicing, no doubt, the thoughts of many — "This comet is perfectly timed. It fits exactly into observatory planning cycles!" In truth, almost every telescope on the planet will be aimed at Jupiter this July — and a few telescopes off-planet as well. HST will be at work on the comet, of course, but so will Galileo, which has a nearly straight-on view of the impacts. Even Voyager 2 gets into the act with its ultraviolet spectrometer. (Unfortunately Voyager's camera, switched off years ago, can't be resurrected.)

Well, whatever happens come July, the odds run strongly against our seeing anything like it again. Those who are prepared will see the most. So fasten your seatbelts. This'll be a summer to remember.

Sincerely,

Robert Burnham
Editor

LETTERS

Mysteries of the Big Bang

Richard Talcott's article "Everything You Wanted to Know About the Big Bang" (January 1994) was an enjoyable read. I was puzzled by several statements, however. At one place he stated "the Big Bang did not occur at some point in pre-existing space" and "there was no outside in which to stand and watch." Later in the article Mr. Talcott stated that we may live in an oscillating universe in which a Big Bang always follows a Big Crunch.

By accepting the possibility of an oscillating universe, do we not also have to accept the possibility that a Big Bang might take place before all of the matter from a previous universe could be crunched, and therefore there could be an "outside" frame of reference? — *Steve Gratton, Marion, New York*

— Although it is conceivable that different regions of a collapsing universe could experience their own Big Crunches, there would still be no way to view any of the resulting Big Bangs from an outside reference. The matter that would go into a Big Crunch gets crushed to infinite density in an enormous black hole and disappears from our spacetime. Any rebound into a Big Bang that includes this matter would likewise appear in a different spacetime. Another way to look at it: If a Big Bang were to occur in our spacetime, we wouldn't provide an outside frame of reference, and if it occurred outside our spacetime, we would have no way to sense it.

Congratulations to Mr. Talcott for writing an article that cut through the doublespeak of most cosmology articles. I was particularly impressed with the author's discussion of a fourth dimension of space. We have long used the term four-dimensional spacetime to refer to three dimensions of space and one of time. Will we at some future point be

(continued on page 12)

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The Audit Bureau

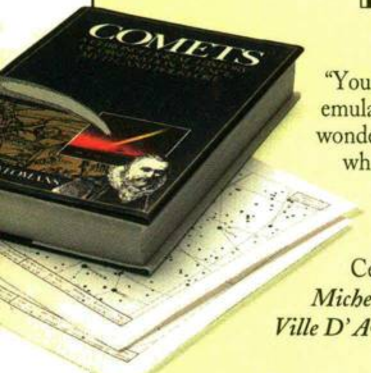
"Not only is Dance useful as an observing session planner, but it's sheer entertainment on some of the historical reconstructions. I recently ran the 'discovery of Pallas by accident in 1802' scenario. It was enjoyable imagining how Olbers felt, when looking for Ceres and chancing to discover Pallas."
Richard T. Coolick,
Bonita Springs, FL

"I have to tell you that I've learned more useful astronomy from your product in a few months than I did in all my time in the classroom. Thank you for enriching my life."
Leslie Kinton,
Guelph, Ontario

"When I was a high-school boy back in the Sixties, I watched Saturn pass behind the Moon. By means of Dance of the Planets I remembered what happened on 8th Oct. 1962! You cannot guess how happy I felt!"
Masahiko Ikeda,
Yokohoma, Japan

Natural Astronomy.

The Science and Art of Dance of the Planets Through the Eyes of Its Users



"Your program emulates wonderfully what may be observed at the eyepiece of my Celestron."
Michel Walch,
Ville D'Avray, France

Dance has enormous appeal, because it combines rigorous modeling criteria with a subtle intuitive approach to dynamic orbital configurations. Please, keep up this kind of work. It is an encouraging example of commitment to high standards in scientific software..."
Francisco N. Laprida,
Buenos Aires, Argentina

Simulations such as Shoemaker–Levy 9 are a natural consequence of this comprehensive gravitational model of the Solar System. Join JPL researchers and thousands of others using Dance of the Planets to visualize and explore our dynamic sky and solar system, past and future.

Comet Shoemaker–Levy 9

Watch the July collisions from any angle—see the locations of the Galilean moons and impacts. Run time back to the 1992 breakup. Continue back to see more of its tortured history since its capture by Jupiter decades ago. These are the first known collisions, but many strong comet perturbations and even other temporary captures can be recreated with Dance.

Find S-L 9. Using Dance, Gary Dowdle of San Antonio was able to image S-L 9 in January with a CCD on a 16" telescope!

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Now you can buy a Dobsonian telescope with quality Meade® optics and components— at a fraction of the price you'd expect to pay.

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10" f/4.5
$565.

12.5" f/4.8
$765.

8" f/6
$395.

6" f/8
$295.

Shown with optional #637 6 x 30mm or #545 8 x 50mm Viewfinders.

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SPECIAL ACCESSORY OFFER!

Through March 31, 1994, at the time you order any Starfinder 6", 8", 10", 12.5", or 16" Dobsonian Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces *and* the Meade #637 6 x 30mm coated achromatic viewfinder for a *total* of only $29.95! Purchased separately, the 2 additional eyepieces and viewfinder sell for $109.85!** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA 25mm eyepieces, with #637 6 x 30mm viewfinder.)*

Starfinder Dobsonian 16

16" f/4.5
$995.

See the Meade General Catalog for details.

Shown with optional 8 x 50mm viewfinder.

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STARFINDER
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Compare Meade Starfinders *feature-for-feature* with other similarly priced Dobsonians!

- **Primary and Secondary Mirrors of Low-Expansion Pyrex® glass!** Unlike the plate-glass optics of other Dobsonians that can become thermally unstable (especially in larger apertures), Meade Dobsonians include the *exact same* professional-quality Grade-A, fine-annealed Pyrex® optical systems used on Meade Starfinder Equatorial Reflectors. Optics that meet the theoretical limits of resolution for their apertures.

- **Precision Rack-and-Pinion Focuser!** An industry-standard full-size rack-and-pinion system with 2.6" of focus travel.

- **Fully-Adjustable 4-vane Secondary Mirror Systems!** *Rigid 4-vane systems* that permit precision alignment of the secondary mirror to the primary mirror.

- **Rigid, Durable, Beautiful Dobsonian Mountings!** Mountings that provide extremely smooth motions of the telescope in both altitude and azimuth. Both telescope axes ride on zero-backlash Teflon/Nylon bearings, facilitating the location and tracking of celestial objects anywhere in the sky. Each mount is manufactured of cabinet-quality materials and designed for a lifetime of use. Handles are provided for easy portability.

- **Optical Tubes:** Starfinder Dobsonians include the same strong, spiral-wound optical tubes used on Starfinder Equatorials *(facing page)*. All telescopes include a multi-coated MA25mm eyepiece as standard equipment. Each tube is factory pre-drilled for the optional 6 x 30mm or 8 x 50mm viewfinder.

- **Performance!** A Meade Starfinder Dobsonian or Equatorial Telescope opens up the skies to an extremely wide range of serious visual observing: all 110 Messier objects, thousands of NGC objects—nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning, high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography and even for limited deep-space astrophotography.

- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"—$39; 8"—$49; 10"—$69; 12.5"—$79. 16"—$45 packing, shipped truck freight collect.

- **To Order:** Contact one of the authorized mail-order dealers listed on the facing page.

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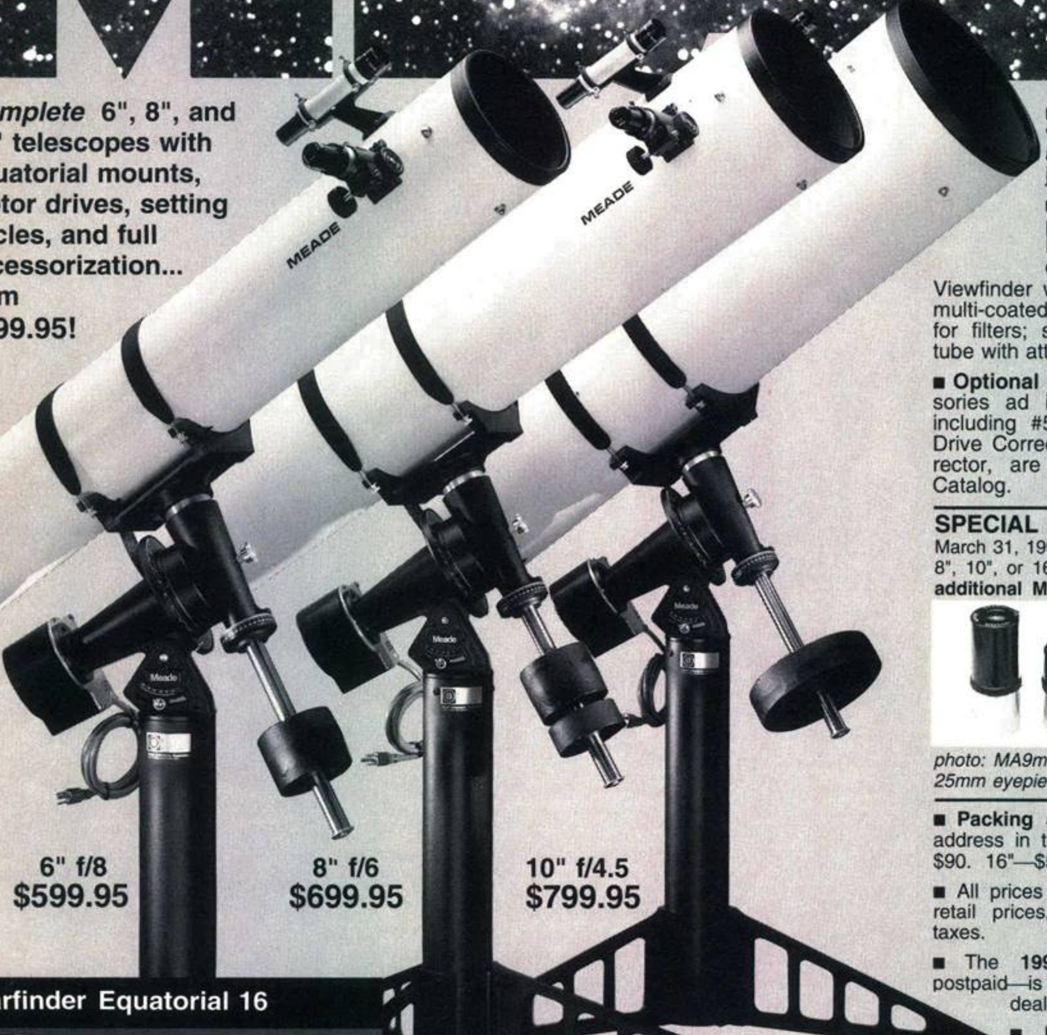
***Complete* 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from $599.95!**

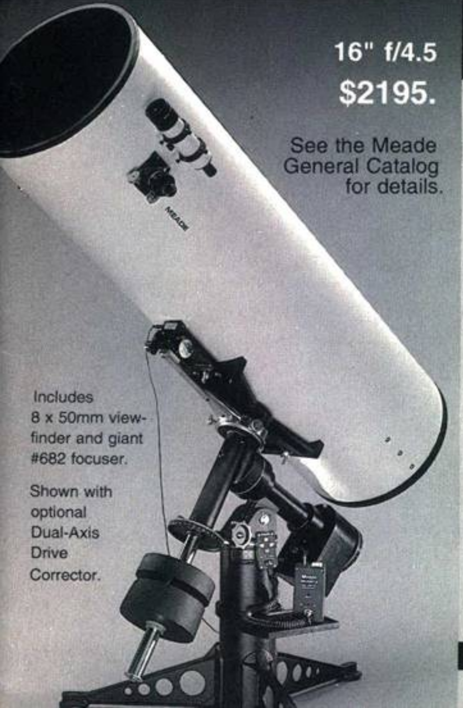


6" f/8
$599.95

8" f/6
$699.95

10" f/4.5
$799.95

Starfinder Equatorial 16



16" f/4.5
$2195.

See the Meade General Catalog for details.

Includes 8 x 50mm viewfinder and giant #682 focuser.

Shown with optional Dual-Axis Drive Corrector.

Standard equipment on 6", 8", and 10" models includes:

- **Superb Optical System:** Includes hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of low-expansion, Grade A, fine-annealed Pyrex® glass.
- **Precision Equatorial Mount:** Manufactured of machined aluminum to tolerances of .001" or better, with 4"-dia. pier and die-cast tripod legs, for rock-solid support of the optical tube. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint objects directly from their catalogued coordinates.
- **Electric Motor Drive** (115v/60Hz) with 6 ft power cord: permits **fully automatic** tracking of celestial objects; plugs into any standard outlet.
- **Standard Accessories and Components:** Precision Rack-and Pinion Focuser (1.25") with full 2.6" travel; coated achromatic #637 6 x 30mm Viewfinder with crosshair eyepiece and 7° field; multi-coated MA25mm (1.25") eyepiece, threaded for filters; strong, durable, spiral-wound optical tube with attractive white finish.
- **Optional Accessories:** See the Meade accessories ad in this issue. Additional systems, including #55 Manual Declination Control, #43 Drive Corrector, and #47M Dual-Axis Drive Corrector, are described in the Meade General Catalog.

SPECIAL ACCESSORY OFFER! Through March 31, 1994, at the time you order any Starfinder 6", 8", 10", or 16" Equatorial Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces for a *total* of only $19.95! Purchased separately, the two additional eyepieces sell for $59.90.** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA 25mm eyepieces.)*

- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"—$65; 8"—$75; 10"—$90. 16"—$55 packing, shipped truck freight collect.
- All prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.
- The **1994 Meade General Catalog**—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.
- For further information call Meade Instruments at 714-756-2291 or contact one of these authorized mail-order dealers:

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

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Orders: 800-843-4780; Info.: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922

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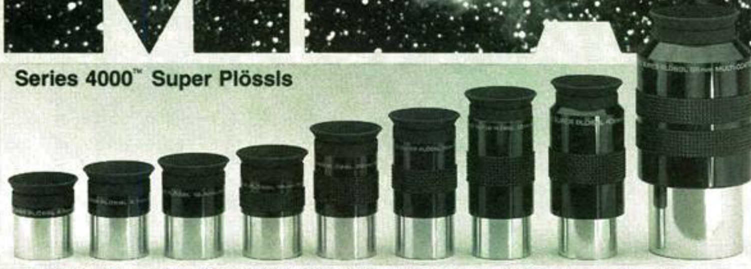
EYEPIECES AND ACCESSORIES

Series 4000™ Super Plössls



Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types for 1994, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm each: **$87.95** (3.29)

32mm (52°); **40mm** (44°); each: **109.95** (3.79)

56mm (52°; 2") **229.95** (4.78)

Series 4000™ f/6.3 Focal Reducer/ Field Flattener

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5" at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture. **$129.95** (3.60)

Series 4000™ Super Wide Angle

For exquisite wide-angle images at low-to-medium powers, ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8, 18, and 24.5mm are superb complements to the #140 Barlow.

Super Wide Angle (SWA; 6-elements; 1.25"; 67°)—**13.8mm: $159.95** (3.49); **18mm: 169.95** (3.69); **24.5mm: 199.95** (3.89); **32mm** (2"): **279.95** (4.78); **40mm** (2"): **339.95** (4.78)

Series 4000™ Ultra Wide Angle

The ultimate eyepieces; extreme image sharpness over an amazing 84° field.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)—**4.7mm: $179.95** (3.29); **6.7mm: 219.95** (3.29); **8.8mm** (1.25"/2"): **269.95** (4.78); **14mm** (1.25"/2"): **329.95** (4.78)

Series 4000™ #140 2x Apochromatic Barlow Lens

The most advanced Barlow Lens available for commercial telescopes; includes 3-element, air-spaced optics, multi-coated. Unmatched in image resolution, contrast, and color correction. Accepts1.25" eyepieces. Lens dia. 28mm; clear aperture 26mm.

$79.95 (3.29)

Series 3000™ Plössls

The very latest in eyepieces from Meade optical designers, new Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Available in a wide range of focal lengths from 5mm through 25mm. All five eyepieces are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. Manufactured exclusively for Meade Instruments by one of Japan's leading lensmakers, Series 3000 Plössls produce excellent results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$59.95** (3.29) **Any 2: $52.95** each; **Any 3: $48.95** each; **Any 4 or 5: $46.95** each.

Series 3000™ Plössl 40mm

A perfect complement to the Series 3000 Plössls at left, this all-new Plössl 40mm produces spectacular low-power, wide-field results with any telescope. Includes classical 4-element Plössl optics, multi-coated. Barrel dia. 1.25", threaded for filters. Apparent field: 44°. **$79.95** (3.79)

Series 4000 Photo-Visual Color Filters (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue. each **$12.95** (2.29)

Moon Filter #ND96—Reduces brightness by 87%. **15.95** 2.29)

Set #1—4 filters: #12, #23A, #58, #80A **49.95** (2.79)

Set #2—4 filters: #11, #25A, #47, #82A **49.95** (2.79)

Set #3—4 filters: #8, #21, #38A, #56 **49.95** (2.79)

Sets #1 & #2—8 filters **89.95** (3.29)

Sets #1, #2, & #3—12 filters **129.95** (3.48)

FREE!

Series 4000™ EYEPIECES!

Through May 31, 1994, buy Meade Series 4000 Eyepieces at the regular price and receive additional eyepieces absolutely FREE! It's this simple:

Buy ANY TWO Super Plössl Eyepieces: SP 6.4, 9.7, 12.4, 15, 20, 26, 32, 40mm

Receive ANY ONE eyepiece FREE: SP 6.4, 9.7, 12.4, 15, 20, 26mm

Buy ANY ONE Eyepiece: SP 56mm, SWA 13.8, 18, or 24.5mm

Receive ANY ONE eyepiece FREE: SP 6.4, 9.7, 12.4, 15, 20, 26mm

Buy ONE: Super Wide Angle 32mm (2")
Receive ONE: SWA 13.8mm FREE

Buy ONE: Super Wide Angle 40mm (2")
Receive ONE: SWA 18mm FREE

Buy ONE: UWA 4.7mm or 6.7mm
Receive ANY ONE eyepiece FREE: SP 6.4, 9.7, 12.4, 15, 20, 26mm

Buy ONE: Ultra Wide Angle 8.8mm
Receive ONE: SWA 13.8mm FREE

Buy ONE: Ultra Wide Angle 14mm
Receive ONE: SWA 18mm FREE

This offer is valid between February 20 and May 31, 1994, at participating Meade dealers and is subject to eyepiece availability.

#911B
#910B
#908B

#911N
#910N
#908N

Series 4000 Nebular Filters—Premium multi-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high contrast observing of faint nebulae.

#908B—Threads into 1.25" eyepieces; 26mm dia. **79.95** (2.98)

#910B—Threads into 2" eyepieces; 44mm dia. **119.95** (3.29)

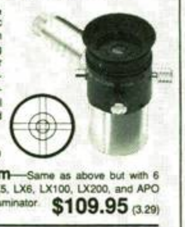
#911B—Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia. **99.95** (3.29)

#908N—Threads into 1.25" eyepieces; 26mm dia. **89.95** (2.98)

#910N—Threads into 2" eyepieces; 44mm dia. **129.95** (3.29)

#911N—Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia. **119.95** (3.29)

World's Most Advanced Illuminated Reticle Eyepiece

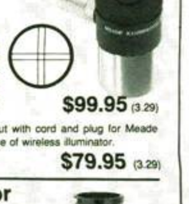


Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Internal batteries included. Multi-coated optics. Bullseye reticle. 1.25"

$129.95 (3.29)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator. **$109.95** (3.29)

MA 12mm Illuminated Reticle Eyepiece



Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Includes wireless red LED illuminator with internal batteries and variable brightness control. **$99.95** (3.29)

MA 12mm–Same as above, but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator.

$79.95 (3.29)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter **$99.95** (3.29)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-Mount, available separately.

.965": $27.95 (2.79) **1.25": $29.95** (2.79)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-Mount for your camera. **$39.95** (2.79)

Tele-Extenders

For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Use with T-Mount for your camera.

Basic Tele-Extender: *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos. **$29.95** (2.79)

Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece. **$39.95** (2.79)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera. **$26.95** (2.79)

2X Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25" **$47.95** (3.29)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25" **$59.95** (3.29)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated. **$47.95** (2.79)

Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, these 3-element Modified Achromatic eyepieces give sharp, faithful, well-corrected images of the Moon, planets, and deep-space at an economical price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

each: **$29.95** (2.79)

HOW TO ORDER

■ Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.

■ Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.

■ Meade accessories may be ordered from any Meade Advanced Products dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
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Orders: 800-843-4780; Info: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922

FOCUS CAMERA, Brooklyn, NY.
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LUMICON, Livermore, CA.
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SHUTAN CAMERA & VIDEO, Chicago, IL.
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Orders & Information: 416-783-4140.

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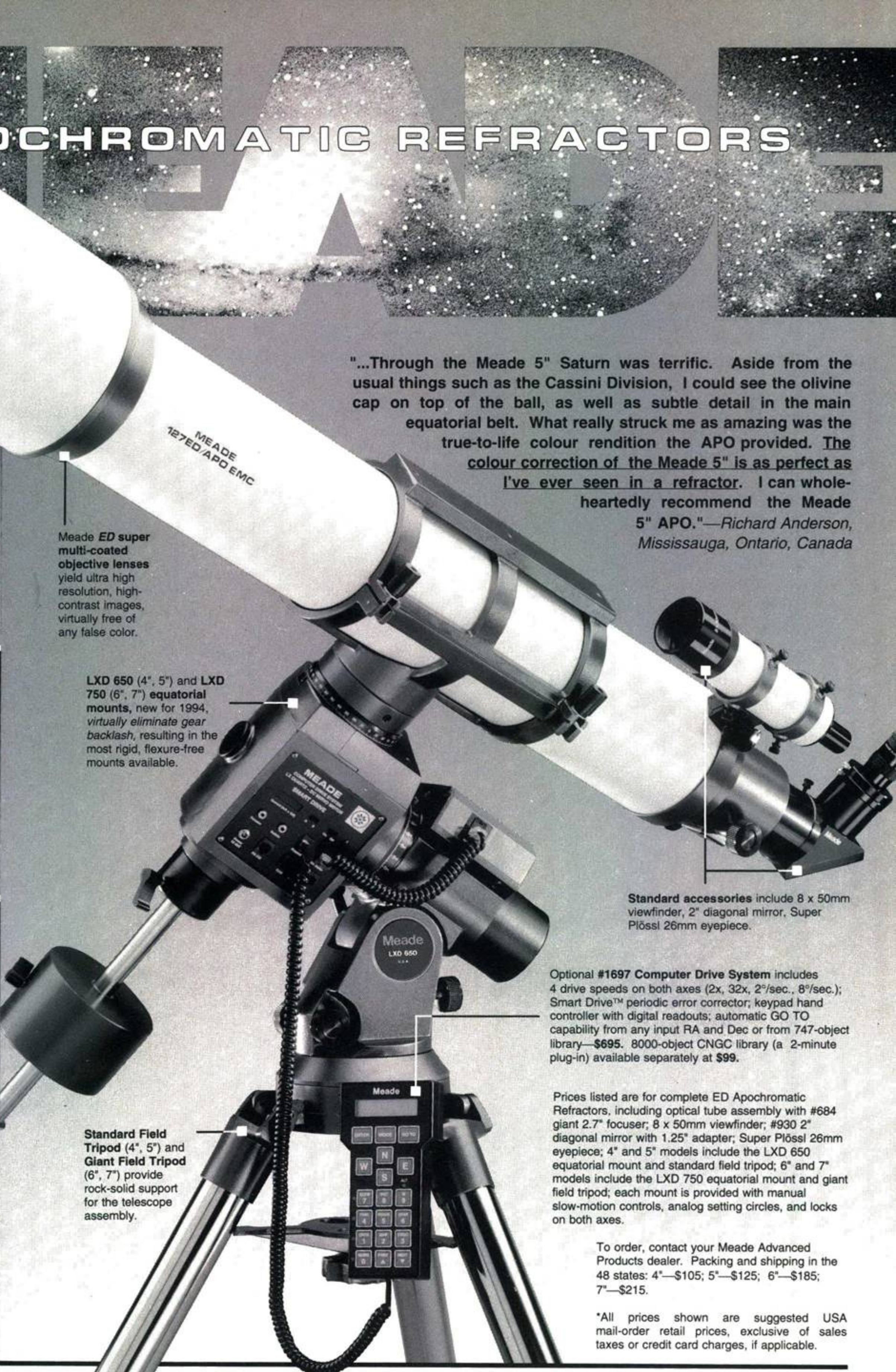
ED APOCHROMATIC REFRACTORS



"...Through the Meade 5" Saturn was terrific. Aside from the usual things such as the Cassini Division, I could see the olivine cap on top of the ball, as well as subtle detail in the main equatorial belt. What really struck me as amazing was the true-to-life colour rendition the APO provided. The colour correction of the Meade 5" is as perfect as I've ever seen in a refractor. I can wholeheartedly recommend the Meade 5" APO."—*Richard Anderson, Mississauga, Ontario, Canada*

Meade ***ED* super multi-coated objective lenses** yield ultra high resolution, high-contrast images, virtually free of any false color.

LXD 650 (4", 5") and **LXD 750** (6", 7") **equatorial mounts,** new for 1994, *virtually eliminate gear backlash,* resulting in the most rigid, flexure-free mounts available.

Standard accessories include 8 x 50mm viewfinder, 2" diagonal mirror, Super Plössl 26mm eyepiece.

Optional **#1697 Computer Drive System** includes 4 drive speeds on both axes (2x, 32x, 2°/sec., 8°/sec.); Smart Drive™ periodic error corrector; keypad hand controller with digital readouts; automatic GO TO capability from any input RA and Dec or from 747-object library—**$695.** 8000-object CNGC library (a 2-minute plug-in) available separately at **$99.**

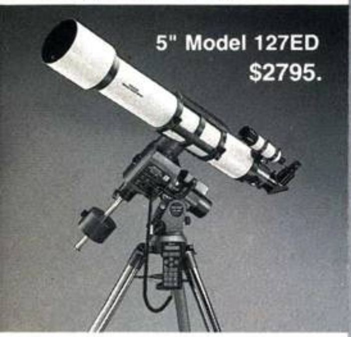
Standard Field Tripod (4", 5") and **Giant Field Tripod** (6", 7") provide rock-solid support for the telescope assembly.

Prices listed are for complete ED Apochromatic Refractors, including optical tube assembly with #684 giant 2.7" focuser; 8 x 50mm viewfinder; #930 2" diagonal mirror with 1.25" adapter; Super Plössl 26mm eyepiece; 4" and 5" models include the LXD 650 equatorial mount and standard field tripod; 6" and 7" models include the LXD 750 equatorial mount and giant field tripod; each mount is provided with manual slow-motion controls, analog setting circles, and locks on both axes.

To order, contact your Meade Advanced Products dealer. Packing and shipping in the 48 states: 4"—$105; 5"—$125; 6"—$185; 7"—$215.

*All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

4" Model 102ED $2195.*



5" Model 127ED $2795.

6" Model 152ED $4495.

7" Model 178ED $5495.

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Thousand Oaks Optical solar filters are recognized around the world for their quality, consistent density and even coating across the entire aperture. We specialize in solar filters only and are the largest solar filter manufacturer in the world. Filters are available to fit all brands of telescopes and binoculars. **Thousands of our filters are in use around the world. The preferred choice of telescope dealers and exclusively used by NASA aboard the Space Shuttle.**

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GLASS (Full Aperture) Type 1

Made from high quality hand select glass, machine polished and **TRIPLE COATED** with a Nickel-Chromium alloy. Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

Aperture	Mounted	Aperture	Unmounted
2.4"	$49.00	2.4"	$39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5 to 4"	49.00
4-1/4" to 5"	74.00	4-1/4" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
12.5" to 13.1"	149.00	12.5" to 13.1"	129.00
14"	169.00	14"	149.00

40mm to 80mm Binoculars - Mounted .... $92.00 pr.

GLASS (Full Aperture) Type 2

Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

Aperture	Mounted	Aperture	Unmounted
2.4"	$62.00	2.4"	$52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5 to 4"	66.00
4-1/4" to 5"	96.00	4-1/4" to 5"	86.00
6"	105.00	6"	95.00
8"	125.00	8"	109.00
10"	139.00	10"	129.00
11"	149.00	11"	139.00
12.5" to 13.1"	179.00	12.5" to 13.1"	159.00
14"	199.00	14"	179.00

40mm to 80mm Binoculars - Mounted .... $115.00 pr.

GLASS (Full Aperture) Type 3

Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 & type 2. Type 3 filters are for photographic use only.

Aperture	Mounted	Aperture	Unmounted
2.4"	$79.00	2.4"	$65.00
3.1"	82.00	3.1"	69.00
3.5" to 4"	99.00	3.5 to 4"	79.00
4-1/4" to 5"	125.00	4-1/4" to 5"	110.00
6"	135.00	6"	115.00
8"	159.00	8"	139.00
10"	172.00	10"	152.00
11"	199.00	11"	179.00
12.5" to 13.1"	229.00	12.5" to 13.1"	209.00
14"	259.00	14"	239.00

Types 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

5 year warranty on Type 1, 2, & 3 filters
Threaded camera filters also available.

H-ALPHA PROMINENCE FILTERS.
Priced from $699-$859 complete & ready to attach to telescope. Please call or write for additional information.

PRICE GUARANTEE: If you see a lower advertised price on any competitive brand glass filter, simply note the brand and we'll automatically match it.

Our 15th year of manufacturing solar filters.

ORDER NOW FOR THE UPCOMING SOLAR ECLIPSE

SOLAR ECLIPSE VIEWERS

Mylar

Aluminized on both sides. Mounted in rigid frame. Mylar window: 1-5/8" x 3-1/8". Each filter supplied in individual envelope. Light transmission is blue.
3" x 5" Overall size .... $1.00 ea.

Plastic

Same as Mylar except this filter yields a sharper image with orange transmission
2-5/8" x 4-5/8" Overall size .... $2.00 ea.

Minimum order of 10 eclipse filters in any combination. Please add appropriate shipping/handling. 10 units: $3.00. Plus $1.00 for each additional 10 units. Minimum credit card order of $25.00. Quantity discounts available starting at 100. Designed for naked eye visual use.

Free brochure available. Foreign inquiries: Please include $1 for return airmail postage of brochure. Proforma invoices available upon request.

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ORDERING INFORMATION: Glass filters are shipped free within the continental U.S. (Please call or write for shipping cost outside of the U.S.) Payment may be made by personal check, bank check or money order. We also accept **VISA, MasterCard and American Express.** (No bank hold on personal checks.) **PLEASE SPECIFY TELESCOPE BRAND AND/OR OUTSIDE DIAMETER MEASUREMENT OF TELESCOPE TUBE.** The cost of the filter is determined by the telescope aperture. The mounting cell fits over and around the end of the telescope tube (friction fit). Unmounted filters are the glass filter without a mounting cell.

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talking about the universe and its five-dimensional spacetime? — *Marvin Jacoby, Longwood, Florida*

The Big Bang is an idea that will not survive as we better understand general relativity. — *Shem Richards, Salt Lake City, Utah*

Just One Look

Rick Shaffer hit the nail on the head when he wrote he had "never met anyone who wasn't favorably impressed with their first view of Saturn" (December 1993). On Saturday, November 14, 1993, I held a small party at our house. Luckily the sky was clear and I had the chance to pull out my new 80mm refractor. We trained the scope on Saturn and the party's 15 guests had the chance to see the Ringed Planet for the first time.

Hearing people's reactions was very satisfying. They ranged from "Wow, this is neat!" to silent awe to joyous laughter to "Boy, do I feel small." The experience clearly demonstrated how seeing Saturn is a powerful way to get people interested in the sky. — *Gaute Hjartaaker, Stord, Norway*

Jonathan Swift, Visionary Astronomer

I read with great interest Damond Benningfield's article "The Odd Little Moons of Mars" (December 1993). The author mentions that Asaph Hall discovered the two Martian moons, Phobos and Deimos, in 1877. However, I feel compelled to point out that in 1726 Jonathan Swift wrote in *Gulliver's Travels* that a nation of people living on a flying island named Laputa had discovered two moons of Mars. It may have been artistic license and coincidence, but Swift beat Hall to the punch by 151 years. — *Thomas R. Shreck, Salisbury, Maryland*

Score One for Astronomy

On October 9, 1993, I arrived at Blackfoot Provincial Park for a night of observing. Soon thereafter a van pulled into the parking lot and stopped near a picnic table. My heart sank when a young couple and their son started hauling firewood into a fireplace.

As I finished setting up my 16-inch reflector we exchanged glances. I kept a nervous eye on their growing fire, and I'm sure they wondered why I was erecting a missile launcher in the middle of a public park. After finishing the setup I walked over and greeted them. I didn't mention the fire, which was now beginning to burn. They did mention the telescope. They asked many questions and I invited them to take some looks at Saturn, the Andromeda Galaxy, and the Hercules Cluster.

I gingerly explained how dark adaptation works. They returned to their site and extinguished the fire. Members of my astronomy club arrived, and we engaged in a lengthy session of looking through the scope. As the young family left around midnight, I overheard the woman make a proposal to her husband and son: "Let's buy a telescope." — *Randy Pakan, Edmonton, Alberta, Canada*

No Stopping the Light over Germany

I should like to inform your readers of a failure to curb light pollution in Germany. Recently the astronomical association in the university town of Tubingen filed a petition to halt the spread of light pollution with the German Bundestag, the equivalent to the U.S. House of Representatives. In their petition the association requested parliamentary support to contain and reverse the trend to illuminate the sky with artificial light sources.

In November 1993 the committee for citizens' petitions rejected the request on the following grounds: The proposal to limit light pollution "not only lacks realism, it would also increase the general tendency towards overegulation of daily life." The committee raised questions about the constitutionality of such restrictions. They further concluded that "compliance with any such law and regulation would be impossible to supervise, and the vast majority of the population would be unable to understand the reason for such legislative action." The committee also reported that "there would be no reasonable relation between improved observing conditions for hobby-astronomers and the costs for achieving them; stray light is the inevitable consequence of our civilization which cannot easily be done away with and therefore has to be accepted."

Not only were the amateur astronomers of Tubingen saddened by this ruling, but also many other astronomers scattered throughout Germany. However, all is not lost. The committee's decision left an open door for legislation to prohibit light pollution at a local or even regional level. We hope our American friends will be more successful with this endeavor. — *Hans Gunter Gnodtke, Bonn, Germany* □

ASTRONOMY welcomes comments about articles and astronomy in general. Send your letters to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187. Letters may be edited for length and clarity.

My Field of Dreams

An Interview with David H. Levy as told to Robert Reeves

Amateur astronomer David H. Levy is well known for his many comet discoveries. Among these is the codiscovery of Comet Shoemaker-Levy 9, the fragmented object that will collide with the planet Jupiter this July.

My first clear memory about astronomy harks back to the second grade when my friends gave me *The Big Book of Stars*. It was 26 pages long, but it seemed huge. Friends of mine walked home from school with me in Montreal, Canada, and looked intensively at the sketches in the book.

In the sixth grade, I had a good teacher who had us give speeches. For some reason, I chose to speak about comets. I remember talking about how comets form and that Halley's Comet was coming, but not for a long time.

A few weeks later, while riding my bicycle to school, I fell off, hit the curb and broke my arm. My cousin gave me a get well present, a book about the planets.

By the time I was 12 I had decided to be an astronomer, partly because I was shy. Astronomy offered me a chance to excel at something without having to compete with other children.

Later, in the summer of 1960, my uncle gave me a small telescope, which I still have. It was quite a thrill to use the same instrument to look at Comet Levy (1990c).

My interest in astronomy weathered a lull in the 1970s while I was in college obtaining a degree in English and a Masters in English Literature. I observed then, but not as much. Then I moved to Tucson in 1979 to have a darker sky, and I have been there ever since.

The Levy Philosophy

What makes astronomy so interesting? I think amateur astronomers are the greatest bunch of people on the planet. I travel to many astronomy get-togethers and meet many amateur astronomers. In a way, they've come to be a sort-of extended family. I feel comfortable with them. One thing that worries me, however, is that some amateurs want to be too much like professionals when, in reality, the two groups are in astronomy for very different reasons.

While amateurs are not doing astronomy for a living, it's certainly not just a hobby for most of us. It is part of our nature. Amateur astronomy offers a world of friendship and nightly and daily activities. An amateur astronomer, by definition, does astronomy for pure love.

If you are a professional astronomer, you are doing astronomy as a daily activity to earn money. There's nothing wrong with this, and the fact that you're a professional astronomer doesn't stop you from being an amateur too.

You do have some advantages as a backyard astronomer. As an amateur, you have more freedom. Nobody expects you to discover something. Nobody expects you to come up with exciting theories or career-sustaining developments.

Whether you're an amateur or a professional, you ought to keep one thing in mind. Explaining astronomy to people carefully is necessary to make a three-dimensional world of the two-dimensional view and show there is a sky out there. This spreading of our astronomical gospel is important, whether it is in a summer camp, school, or any other place. I don't think an astronomer can do anything more significant than teach about the stars and the beauty of the night sky to the youngsters. It doesn't matter how as long as you do it. Take the kids out and say, "See those points of light? They are going to be your friends." Tell them about Halley's Comet, if they were old enough to see it.

A Passion for People

My passion for people extends to some very special characters. Thirteen years ago I wrote an article for ASTRONOMY for Bart Bok's 75th birthday and it was published in February 1982. The phone rang and Bok said, "David, that is the nicest thing anyone has ever written about me, and I can't even talk to you about it." Then he hung up on me.

Then he called back again and said, "David, I just read it again and I am really touched." And he hung up again. Then he called back a third time and said, "If you don't mind, I am sending copies to all of my family." This time he said goodbye before he hung up.

I said to Bok, "If you need a biography written let me know." He said, "No I don't want that done, but if I do you will be the one to do it." I'm happy to say that biography has now come to fruition. *The Man Who Sold The Milky Way; A Biography of Bart Bok* (The

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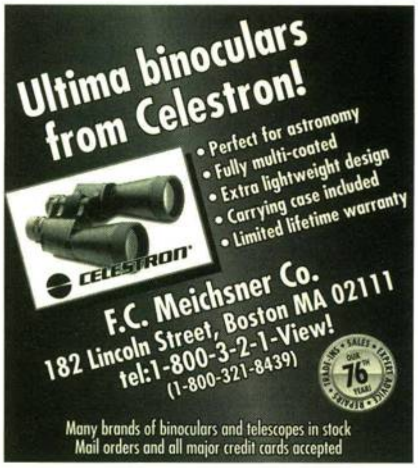
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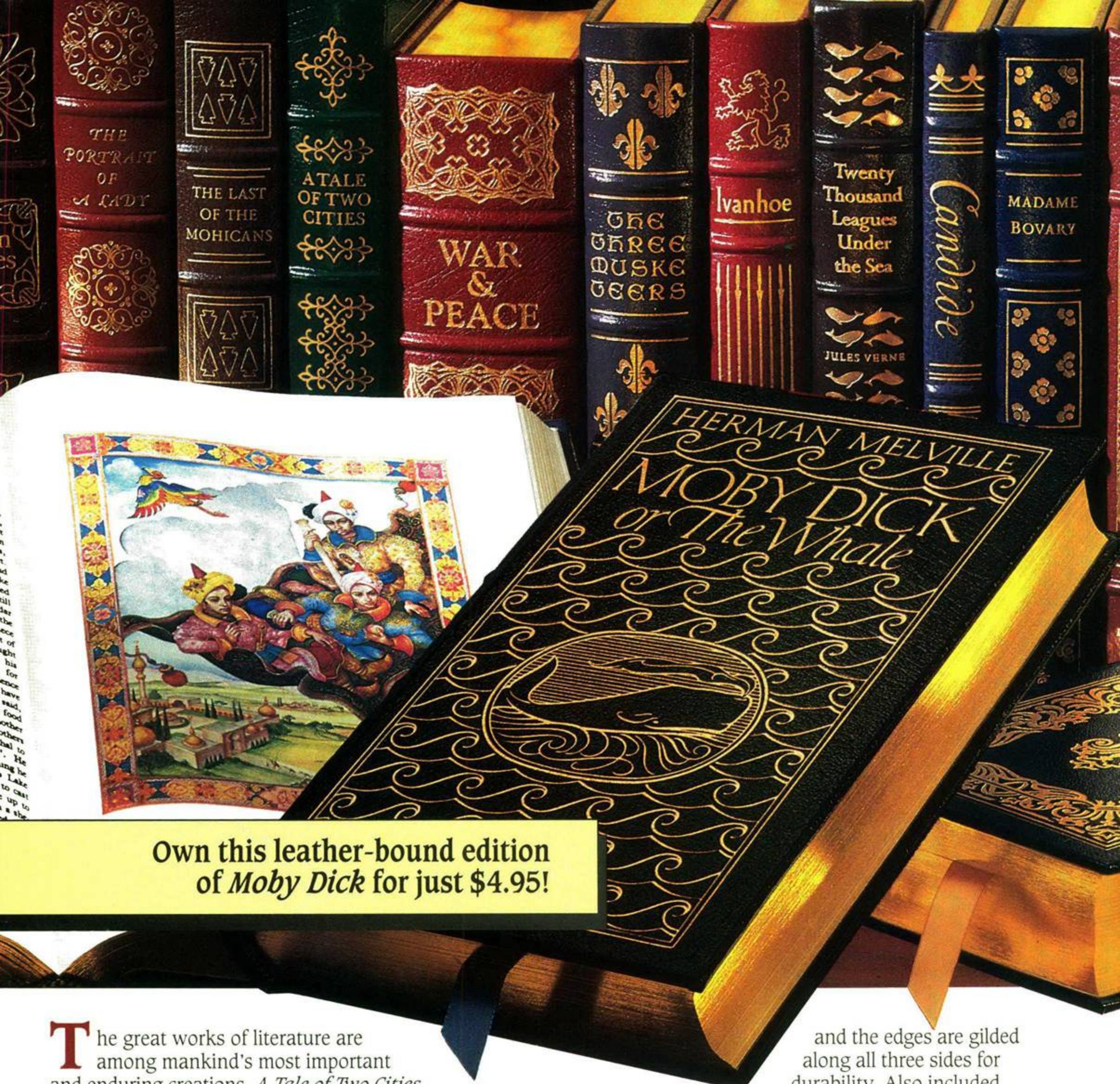
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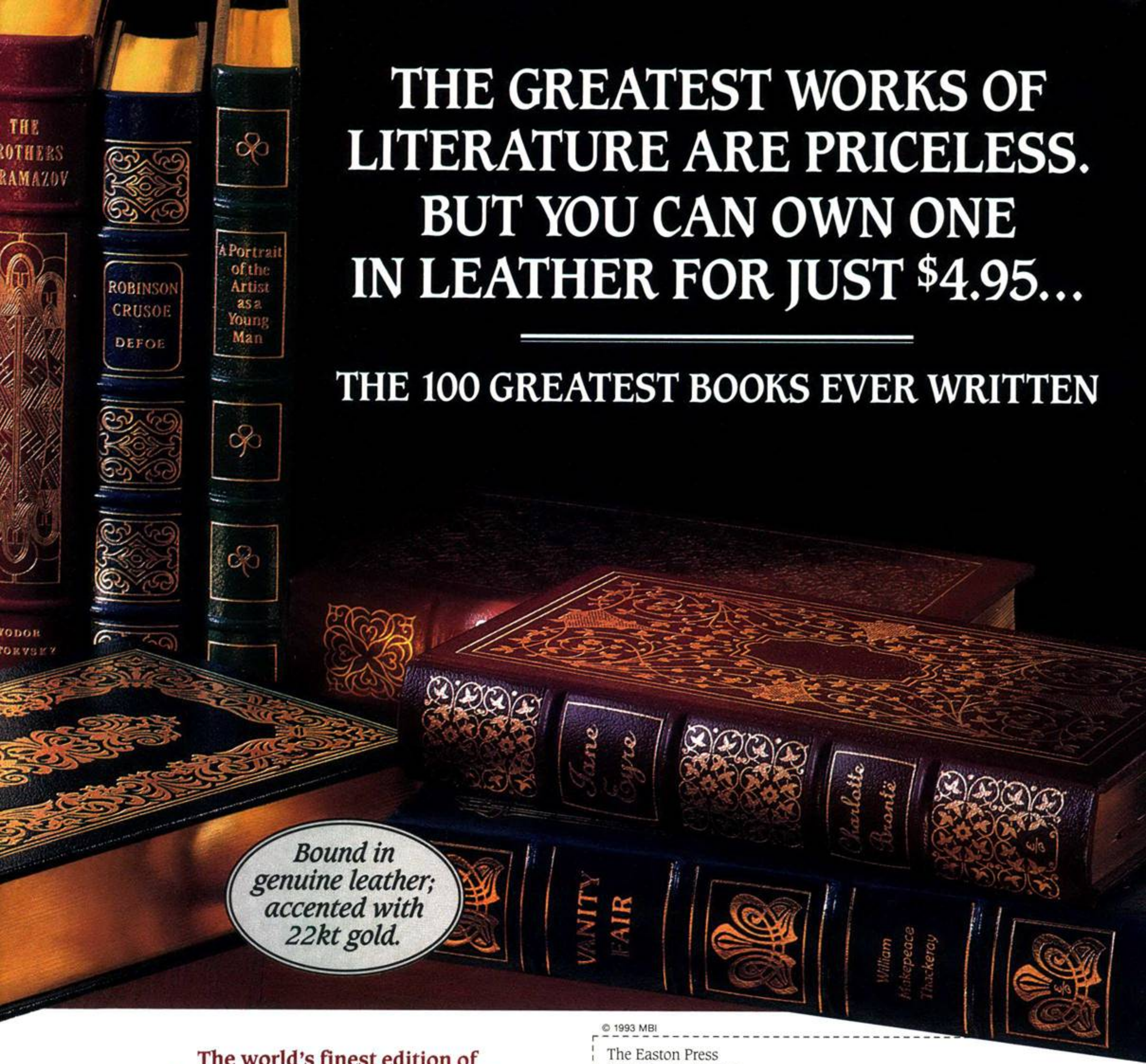
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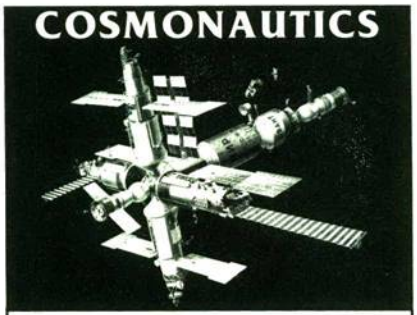

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University of Arizona Press, Tucson), was published in 1993.

I met another great astronomer, Clyde Tombaugh, at a conference in 1980, and we soon became friends. I asked about writing his biography in 1983 and he said "Absolutely, definitely not. I want to do one myself." I waited a year and asked him again. Now the matter was entirely different. By that time, he had time to think about it and said yes.

The project, which I started in 1985, involved a great deal of traveling. I would drive to Las Cruces every month and we would meet, have dinner, and then do a five- or six-hour interview. The next month we would meet again and do a different topic. This went on for about a year. Then I signed a contract with University of Arizona Press in the spring of 1988. In the summer of 1989, I started frequent visits again to check facts with him and have him read chapters. I also conducted other interviews with friends and colleagues. It took six years, but I wanted to write about Clyde because his life is an inspiration to those of us who want to go into the same field.

There is a difference in how Bart and Clyde viewed my doing their biographies. Bart wanted me to do it because I have a degree in English and he thought I write well. Clyde wanted me to do his biography because I know what observing is like.

I would like to do another couple of astronomical biographies. I live and breathe the sky, so if I find an astronomer whose story needs to be told, and I feel I can tell it, I'll be interested in a third project. My heart is drawn toward talking about the lives of inspiring people with important ideas.

My Field of Dreams

Perhaps the greatest pleasure in astronomy comes when you're out under the stars themselves. I do most of my comet scanning from my house about 25 miles southeast of Tucson. I actually started looking for comets on December 17, 1965, back in Montreal. It took 917 hours of searching over a 19-year period before I found my first comet on November 13, 1984.

Every time I go out and look at the sky, I don't know what I am going to see. But the fact that there might be a surprise or two heightens the anticipation. If you look long enough and hard enough, the sky is finally going to look back at you and say, "You have done a good job. Here is a comet."

What got me started on comet hunting was the sight of Ikeya-Seki in 1965. I had already made the decision to start hunting comets, but then I picked up a copy of *Starlight Nights* by Leslie C. Peltier. That is what really inspired me. If I were about to be shipwrecked on a desert island and the captain said I could save only one thing, it would be my copy of *Starlight Nights.* It's the most incredible book I have ever read.

I have three modes in my comet-hunting projects. The first is "The long march begins with but a single step." It is my visual mode of comet hunting. The second mode involves using my Schmidt camera to take images and study them for new comets. I call that approach, "How now Ophelia. I am sick of these numbers." *Ophelia* is what I call my Schmidt camera. The third mode is when I work with other people, and I call that mode "Forward together into the future."

After years of comet searching, I have two words of advice to comet seekers: Keep looking. All the little tricks of the trade must be developed by practice. There is no set formula. I can't give people advice on how to do it. The best way to learn how to do it is to *do it.*

The actual nuts and bolts of comet hunting are fairly simple. It's just an automatic motion where eventually I trip over something and then the excitement starts. While hunting, I enjoy looking at a beautiful sky. It's very dark and very pleasant. I almost always play music. I am not really expecting to find anything. Sometimes, however, the sky has a way of surprising me when I least expect it.

That reminds me of a story. In the summer of 1990, I was observing up at Palomar. The first night, before the observing run started, I set up Minerva, my 6-inch telescope, at the front gate of the observatory and was about to start comet hunting. Then I looked at the Milky Way, which was up in the west. I have seen the Milky Way probably about 7,000 times, nearly every night of my life. Then suddenly it occurred to me that in the middle of that was Comet Levy 1990c, the brightest comet I have ever seen in that little piece of sky.

I looked at my comet and was absolutely transfixed. The comet was never as bright as it was that night, and has never been as bright since then.

In my dreams back in the mid-'60s, I wanted to find just one comet. Now, I have nineteen. I found seven visually from my home and the other twelve were at Palomar as part of the Shoemaker/Levy team.

In backyard astronomy a lot of people have the "Bambi" approach — "Your dreams will come true." The movie *Field Of Dreams* is one of my favorites because it really examines that question of doing something in your life to make your dreams come true. But you really have to work at it. I love watching that movie and then going outside and watching my own field of dreams. ☐

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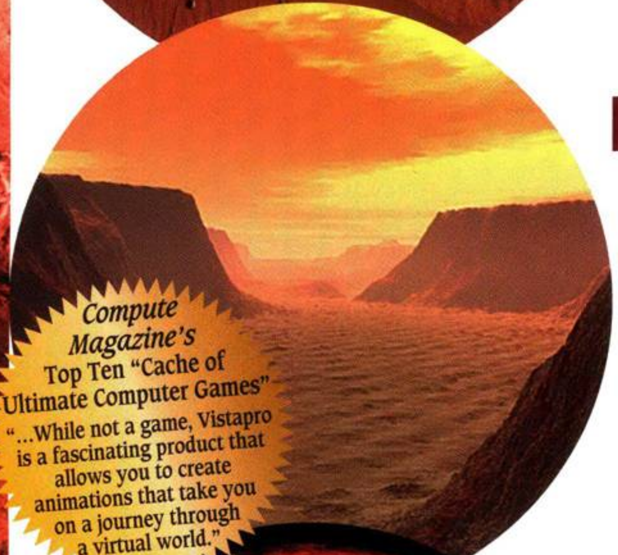

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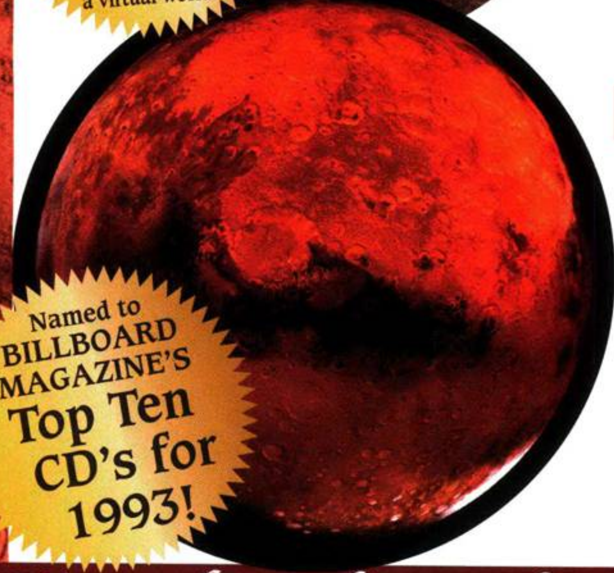

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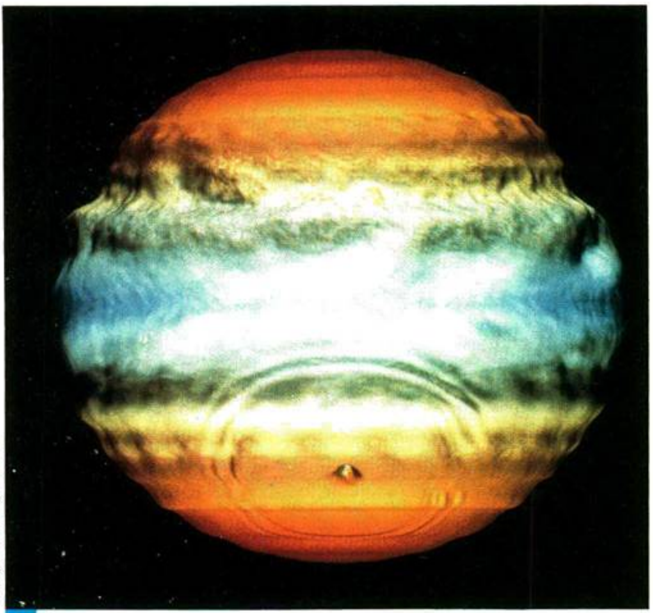
Comet Shoemaker-Levy 9: Making Waves on Jupiter



Joseph Harrington/MIT

MAKING WAVES. Computer simulations of what will happen when Comet Shoemaker-Levy 9 hits Jupiter show that large waves will travel around the planet. The simulation shows the waves two days after an impact.

Big waves are in store for Jupiter this July. That's when the fragmentary nucleus of Comet Shoemaker-Levy 9 will crash into the planet. Traveling at 60 kilometers per second, each of approximately 21 fragments will decelerate and explode within a few seconds as they strike Jupiter. The size of the individual fragments is uncertain, but based on their appearance in photographs, planetary scientists are assuming that they average about 1 km in diameter. Upon impact, such a 1-km fragment would release about as much energy as 250,000 1-megaton hydrogen bombs.

That's big enough that even a huge planet like Jupiter will show some effects. But because Jupiter has no solid surface, the impacts won't produce craters. Instead, each fragment will set off a series of surface waves that will travel around the planet the days after the impact, say MIT researchers Joseph Harrington, Raymond LeBeau, Kari Backes, and Timothy Dowling. Simulating the impacts using a computer model for Jupiter's atmosphere, they have found that the waves resemble the ripples you see in a pond after dropping a rock into it. The scientists hope to compare these simulations to the actual waves the comet produces so as to learn more about the structure of Jupiter's deep atmosphere.

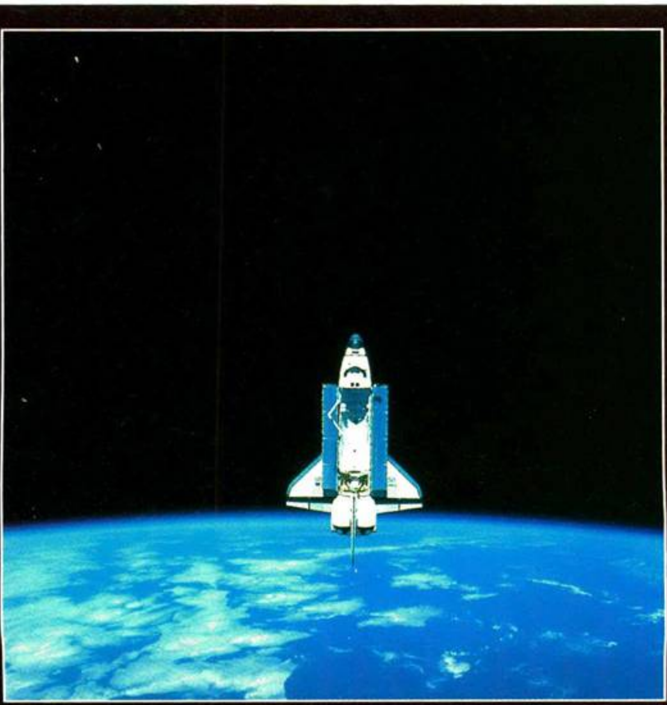
Curtains For COBE

NASA turned off its Cosmic Background Explorer (COBE) satellite on December 23, 1993, because it had fulfilled its goals. COBE was famous for measuring the temperature of the diffuse background radiation — 2.726 kelvins — and for its discovery of extremely faint fluctuations in the background radiation (see "COBE's Big Bang!" in August 1992.)

COBE's mission was an outstanding success. The spacecraft was flown to test the big bang theory of the origin of the universe, and its results greatly strengthened the theory's credibility. Although it is still a mystery exactly how galaxies formed from the minute temperature fluctuations that COBE detected, astronomers feel a lot more confident about the big bang theory because it predicted that these fluctuations should exist and that they would be very small.

Solar Flare Myth?

"The time has come to lay the solar flare myth to rest," says Jack Gosling, a scientist at Los Alamos National Laboratory in New Mexico. Many textbooks state that energetic outbursts from the Sun's surface, or solar flares, cause magnetic storms such as aurorae here on Earth.



THE SPACE SHUTTLE DISCOVERY orbited Earth in September 1993 and was imaged for the first time by an IMAX camera placed on a satellite outside the shuttle. The camera was mounted on a free-flying pallet satellite called Orfeus-SPAS, a joint venture of NASA and the German Space Agency. Footage from the IMAX camera will be assembled into a movie tentatively titled *Destiny in Space.*

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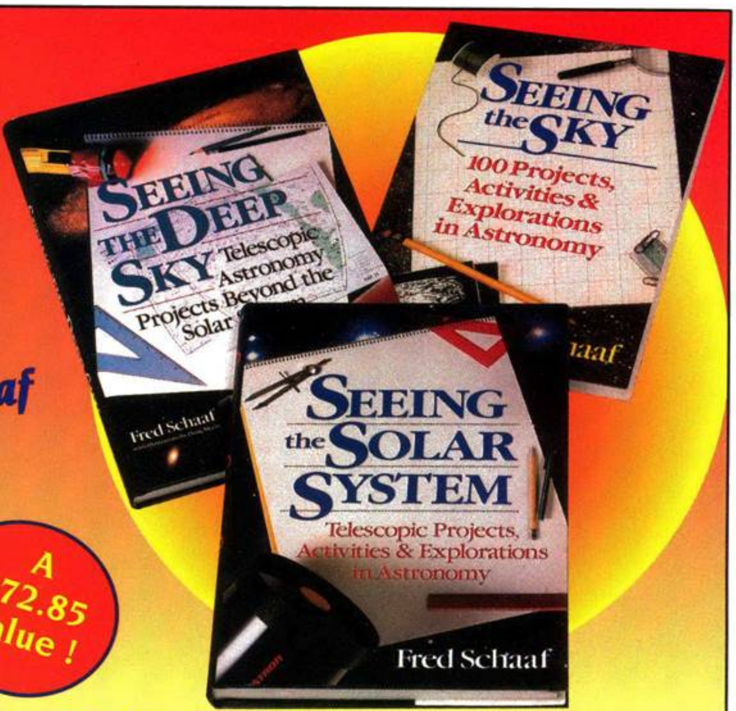
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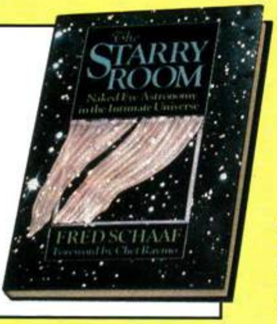

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But this view is wrong, according to Gosling. Although some flares occur at the same time as geomagnetic storms, he points out that a one-to-one association doesn't exist between the two sets of events.

Instead, says Gosling, we should focus on coronal mass ejections, gigantic blobs of hot gas, as the cause of geomagnetic disturbances. Mass ejections do not result from flares but rather from the restructuring of magnetic fields in the Sun's outer atmosphere, or corona. The blobs of gas eventually grow in size to be larger than the Sun itself. When the highly charged particles in the ejected gas pass by Earth, they can distort our planet's magnetic field, producing aurorae.

Small Mission to a Big Rock

NASA has initiated a new mission to send a small spacecraft to orbit the asteroid 433 Eros. The craft, called the Near-Earth Asteroid Rendezvous (NEAR), will be launched in February 1996 and will reach Eros in late December 1998. This mission will be the first in NASA's new low-cost Discovery program (see "Cheap Shots," August 1993).

Flight plans call for NEAR to spend a year or more in orbit around Eros, at times coming within 10 km of the asteroid's surface. NEAR will measure the asteroid's physical properties, map its surface features, and survey its geology.

The craft's trip to Eros is lengthy. NEAR will sail out into the main asteroid belt between Mars and Jupiter (where it will encounter another small asteroid, 2968 Iliya, in August 1996), then it will come back to Earth and fly past it in January 1998. Finally, NEAR returns to the main belt, reaching Eros in late December 1998.

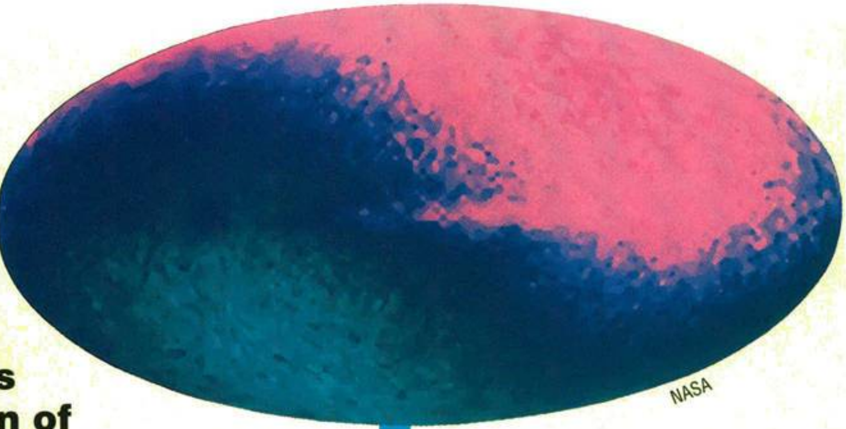
Eros has never been seen close-up, but from its

GALAXY CLUSTER FORMING?

Gerard A. Luppino/University of Hawaii

The dense cluster of galaxies MS 0440+0204 is providing astronomers with a look at a distant cloud of material in the process of merging. Astronomer Gerard A. Luppino of the University of Hawaii and his coworkers imaged the cluster using the Canada-France-Hawaii Telescope on Mauna Kea. They found six bright elliptical galaxies, several fainter ones, and a dense soup of ionized gas collapsing together, forming a cD galaxy like those that dominate the centers of many closer galaxy clusters.

Luppino and his colleagues also caught faint blue arcs of light in their image of the cluster. The arcs surround the brightest parts of the visible galaxies in the cluster and are presumed to be formed by gravitational lensing. They represent the light from a distant background galaxy cluster that is being bent and distorted by MS 0440+0204.



NASA

OUR LOCAL GROUP OF GALAXIES STREAMS toward the constellation Hydra, as shown by COBE's measurement of the two-lobed nature of the cosmic background radiation.

COBE Shows Motion of Local Group

The cosmic background radiation observed by the Cosmic Background Explorer satellite (COBE) has a definite two-lobed nature, as seen in the image above. This dipole results from the motion of our Local Group of galaxies toward the constellation Hydra, between Crater and Antlia. Owing to the Doppler effect, motion of the Local Group toward Hydra causes the background radiation to appear slightly bluer or hotter in that direction and slightly redder or cooler in the opposite direction.

Alan Kogut of the Universities Space Research Association in Greenbelt, Maryland, and members of the Differential Microwave Radiometer team found that the Local Group is streaming toward Hydra at 630 km per second. This confirms the motion seen by astronomers who measured the velocities of galaxies at ground-based observatories (see "Cosmic Tug of War," July 1993) and helps to pin down its amplitude and direction.

THE MOST POWERFUL COMPACT RADIO IN THE WORLD!

Winner! Electronics Industry Association Award for Innovation in Design.
GRUNDIG
YB 500
WORLD RECEIVER

First and ONLY world band with award-winning vertical design. Measures approximately 7⅞" x 4½" x 1⅝", with built-in stand and retractable ferrite antenna.

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THE GRUNDIG YB-500
FM/AM Shortwave Receiver

Listen! Here is the BIG BREAKTHROUGH in powerful performance and design. Not in stores. . .Now available to you in the U.S.A. from Willabee & Ward. No other compact radio packs all these powerful features.

▲ POWERFUL RECEPTION. The Grundig YB-500 **does it all:** pulls in AM, FM, FM stereo, **every** SHORTWAVE band, even aviation, military and ship-to-shore. All with lock-on digital precision.

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Powerful Memory.

The BBC and *all* major world broadcasters are pre-set for instant retrieval. You can add 40 more stations on any band and display call letters for reference. No other radio at this price offers such powerful memory.

Also has instant keypad access to all frequencies. Illuminated, adjustable LED display for bedside use. Advanced RDS FM station information display. It will be years before other makers catch up with the YB-500. But it is available today from Willabee & Ward.

Powerful Value.

The Grundig YB-500 is only $299 (plus $9.50 shipping and handling), payable in eight monthly credit card installments of $38.56. Includes 4 AA batteries, deluxe travel pouch, stereo headphones, owner's manual, and Grundig's shortwave listening guide. INTRODUCTORY OFFER: ORDER NOW AND GET A FREE DUAL-VOLTAGE INTERNATIONAL ADAPTER!

Grundig 1-year warranty on parts and labor. 30-day money back guarantee. Grundig is to radios what BMW and Mercedes are to cars. European look! European sound! European quality! Order now!

Phone orders normally shipped next business day.

Call Toll-Free: 1-800-367-4534
Extension 697-310

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Willabee & Ward
47 Richards Avenue • Norwalk, CT 06857

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Extension 697-310

Please send me ________ Grundig YB-500 Digital All-Band Shortwave Receiver(s). For each receiver, charge eight installments of $38.56* to my credit card:

☐ VISA ☐ MasterCard ☐ Discover ☐ Am. Ex.

Credit Card No. Exp. Date

Name ____________________
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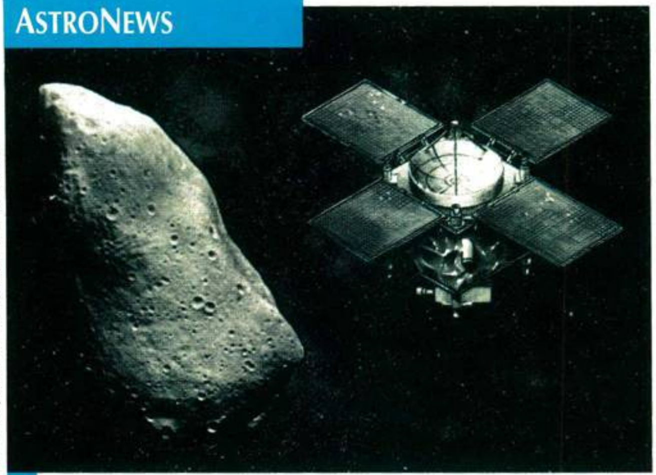
☐ I prefer not to pay by credit card and will pay by check. Enclosed is my check for $299 plus $9.50 shipping/handling, a total of $308.50* for each receiver.

**Any applicable sales tax will be billed with shipment. Higher shipping/handling outside U.S.*



Johns Hopkins University Applied Physics Lab

GETTING NEAR-ER. An ambitious plan to orbit the asteroid Eros lies at the heart of the Near-Earth Asteroid Rendezvous (NEAR) mission. This new NASA venture is due for launch in early 1996.

telescopic properties planetary scientists believe it measures about 35 by 15 by 13 km. It is one of the larger main-belt asteroids and probably has a mixed composition. Its surface is likely covered with dusty, cratered rubble. Like Gaspra and Ida (visited by Galileo), Eros is an S-type asteroid, although it differs from them in spectral properties.

NEAR carries only a few instruments: a visible light camera, a near-infrared imaging spectrograph, an X-ray and gamma-ray spectrometer, and a laser altimeter that is part of the navigation system. By tracking NEAR's orbital motions, planetary scientists also hope to map Eros' gravity field.

The close orbit and long time spent at Eros mean that NEAR will provide highly detailed views of the object. Scientists expect to use the data to learn more about large asteroids as well as to compare it with Gaspra and Ida, the only other two asteroids encountered by a spacecraft.

Subaru Mirror Progresses

Fabrication of the mirror for the 8-meter Subaru telescope being built by Japan's National Astronomical Observatory on Mauna Kea in Hawaii has passed another major milestone. Corning Incorporated has fused over 40 hexagons of glass, each five feet in diameter and 10 inches thick, into one flat mirror blank.

Next, workers will grind the blank flat on both sides, and in mid-1994 they will place the mirror in a special oven for reheating. The oven's curved bottom will cause the mirror's edges to sag about 11 inches, giving the mirror its desired concave shape. After the mirror cools, Corning will ship it to the polisher in late 1994 to start three years of polishing and figuring.

Probing the Universe From the Bottom of the Sea

A new telescope will look for black holes and quasars from the ocean floor. Impossible, you say? You'd be right if the telescope were an optical instrument, but this one looks for neutrinos, high-energy particles that rarely interact with matter. Researchers put the scope in the ocean to prevent lower energy cosmic particles from reaching their detectors.

Called DUMAND (Deep Water Muon and Neutrino Detector), this $12 million

(continued on page 26)

AMATEUR NEWS

Astronomy Day Turns 21

ASTRONOMY and Astronomy Day have something in common. They both began in 1973. They were both started by visionaries — ASTRONOMY by Steve Walther and Astronomy Day by Doug Berger. This year, Astronomy Day, along with the magazine that helps to promote it, turns 21. The big event takes place on April 16, 1994.

Berger's idea for an Astronomy Day was simple. Rather than try to get people to travel to a dark-sky site, take astronomy to the people. Special events set up in busy places like strategically placed street corners and shopping malls would invariably let the public know about what they can see in the sky, as well as publicize astronomy clubs, planetariums, and science centers.

This year, why not get involved with promoting astronomy day? You'll help spread the joy of amateur astronomy and publicize the astronomy club you're affiliated with. The Astronomical League, a national, nonprofit organization, can help. Contact the Astronomy Day Coordinator, c/o Public Museum of Grand Rapids, 54 Jefferson SE, Grand Rapids, Michigan 49503. Last year the League provided astronomy clubs with an *Astronomy Day Handbook* containing suggestions on how to participate in the event. If you do not have a copy, you can obtain one from the League as long as their supplies hold out. They will also give you information on low-cost liability insurance for your club, which protects you at public facilities.

The League's Astronomy Day Coordinator issues an award for the best Astronomy Day event. Last year's winner was the Sonoma County Astronomical Society in Santa Rosa, California. Honorable mentions went to the Charles Hayden Planetarium in Boston, the Morehead Planetarium in Chapel Hill, North Carolina, and the Saguaro Astronomy Club in Phoenix. For more information, please send us an SASE. — *Gary Tomlinson*

Near-Earth Asteroid Project

To encourage the study of asteroids and help identify those in near-Earth orbits, astronomers have formed the Near-Earth Asteroid Reconnaissance Project (NEAR). A joint effort between amateur and professional astronomers, NEAR will combine the vast numbers of backyard astronomers with the observational capabilities of professional observatories.

Although many near-Earth asteroids have been discovered, occasionally backyard astronomers find new ones. NEAR hopes to connect amateurs with observatories so they can report possible discoveries of asteroids and follow along as scientists determine their precise positions, motions, and orbital elements. Backyard astronomers will communicate with the scientists using the CompuServe and Internet e-mail networks.

Interested amateurs should contact Leslie M. Golden, Dept. of Physics, University of Illinois, 801 West Taylor St., Chicago, Illinois 60607.

"The **MK65** blows away my Brandon and Genesis refractors!" - C. Zdeb

NEW!
6" f/10
Maksutov-Cassegrain

MK65/Polaris mount package - a complete telescope - **only $1495**($25)

MK65/sturdy Alt/Az. mount package (with slow-motion) - only **$1295**($20)

This is the opportunity of a lifetime! Own a high quality 6" f/10 Maksutov-Cassegrain telescope for a fraction of what you would expect to pay.

Aperture-for-aperture, the Maksutov is recognized to be superior to any other telescope design. **JMI** stands behind these little beauties from Russia.

MK65 Optical Tube Assembly	**$895**($16)
Eyepiece package (30mm/18mm/3X Barlow)	**$110.00**
Adaptor Plate for Polaris/Super Polaris/Great Polaris	**$29.00**
for GM-8 and G-11	**$50.00**

"I, as well as two other experienced observers, have been comparing the Intes **MK65** to the Quantum 6", and we all agree [the **MK65**] is equal in resolution and equal or better in contrast." - S. Dunne

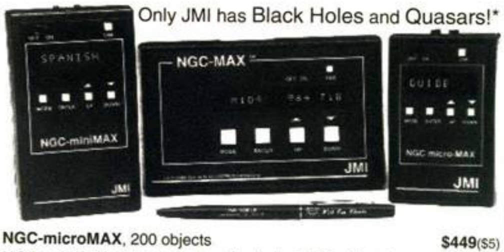
"The Intes optics are superb! Several of my observing friends and I have been comparing the **MK65** side-by-side with the Questar, and the **MK65** is right there. When you consider the portability, optics and price, it's incredible." - D. Murray (45 years experience)

"I haven't seen a set of optics to match this in any telescope for quite a while...they are *bloody superb!* My Ronchi screen shows absolutely straight lines." - C. Garner, Australia

Order this industry-first products catalog on video for only $10 ppd., and we'll **DOUBLE YOUR MONEY** with a $20 gift certificate. (Add $10 for overseas PAL version. VHS tape format only.)

Industry First

Only JMI has Black Holes and Quasars!*



NGC-microMAX, 200 objects	**$449**($5)
NGC-miniMAX, Planets, polar align help, 3800 objects!	**$569**($5)
NGC-MAX, Planets, polar align help, RS-232, 12,100 objects	**$769**($5)

Our popular "**MAX**" computer units are ready to use with your choice of over 70 models of commercial telescopes. They feature high resolution (0.09°) optical encoders and do not require polar alignment or leveling! Easily find any object in the computer's database, even add your own! Ask for our free encoder installation instructions detailing how our encoders mount to your own telescope.

*Quasars and Black Hole candidates in **NGC-MAX/NGC-miniMAX**.

"The **NGC-MAX** has turned our 17.5" Dobsonian into a telescope that anyone can use!" - D. Bradstreet, PA

SGT-MAX Telescope encoders-to-PC system with **The_Sky** software for IBM PC compatibles. MS-DOS and Windows versions.

55,000 object database.	**$599**($5)
272,000 object database.	**$669**($5)
NEW! CD-ROM version with 19 million objects	**$719**($5)

(Software-only orders deduct $470)

NEW! Only from JMI

Encoders install here

At last! Encoders for the popular Polaris mount. Use any of our four computer units with your Polaris-mounted telescope. Even use the new **MOTOTRAK IV** or **V** with our R.A. and Dec. motors.

S94DP

Zero image shift!

"I was able to see for the first time the Crepe Ring...I feel this is due to the very fine focusing that can be done with the **NGF-S**." - Donald A. Regan

NGF-1 Top-of-the-line, designed to make your telescope a showpiece. Polished aluminum body standard, black upon request (drawtube always black). Includes 1.25" adaptor.

manual, 6 SS bearings*	**$229**($3)
with integrated **MOTOFOCUS**	**$299**($3)

NGF-2 Superior for manual focusing. Includes 1.25" adaptor. Black only.

manual, 4 SS/2 AA bearings*	**$179**($3)
with **MOTOFOCUS**	**$249**($3)

NGF-3 Advanced focusing system. 1.25" adptr. Black.

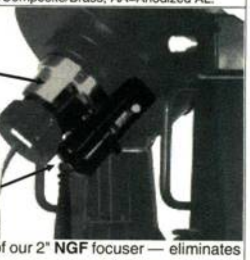
manual, 4 CB/2 AA bearings*	**$149**($3)
with **MOTOFOCUS**	**$219**($3)

NGF-4 Advanced focusing system for the budget-minded. Single focusing knob. Non-coated aluminum body. 1.25" adaptor optional.

manual, 4 CB/2 AA bearings*	**$119**($3)
with **MOTOFOCUS**	**$179**($3)
2"-1.25" adaptor	**$19.95**

*SS=Stainless Steel, CB=Composite/Brass, AA=Anodized AL.

NGF-S
Zero image-shift focusing!



MOTOFOCUS
Eliminates user-induced vibrations. From **$99.95**($3)

NGF-S A special version of our 2" **NGF** focuser — eliminates frustrating image shift while fine-focusing 8"-14" Schmidt-Cassegrain's. Includes built-in motor, hand unit. **$289**($3)

JMI HOT PRODUCTS SHOWCASE!!!

Jim's Mobile Inc. • 810 Quail St. Unit E • Lakewood, CO 80215 • Orders: 800-247-0304 • Info: 303-233-5353 • FAX: 303-233-5359

PHONE/MAIL ORDER: VISA, MasterCard, personal check, or money order. **USA & CANADA:** Add shipping charge shown in (parentheses) after price. **OVERSEAS ORDERS WELCOME:** Send VISA or MasterCard number with expiration date, or bank check in US$; add 7% of price for customs preparation and air mail shipping ($15 minimum). Prices subject to change.

JMI - Your Starfinder accessories headquarters!

MOTOFOCUS $109.95, MOTODEC $89.95, manual slow-motion **Tangent Arm drive $109.95** ($159.95 for 16"). All work with our **MOTOTRAK IV** and **V** quartz drive correctors. Add $3 each for shipping. Encoder installations also available.

JMI Does Dobsonians! In addition to the Odyssey and Obsession line of Dobsonians, we offer encoder installations to fit most homemade models too! (Obsession 18" shown.)

Order Levelling Wheeley Bars by April 30, 1994 and deduct $25!

Wheeley Bars now available for Starfinder 6"-10", Meade field tripod, C-11/C-14, Polaris/Super Polaris/Great Polaris, Ultima 8/11. **$109.95**($10) Levelling, add $50.

MOTOTRAK V

Triple-control drive corrector (dual-axis plus focus) with Lunar, Solar, Sidereal, King and user-definable tracking rates; PEC; CCD auto-guider jack; blinking reticle output; mounting bracket; wall transformer; and cigarette lighter plug. **$329**($10)

Order with **MOTOFOCUS** or **MOTODEC**	**$70** ea.
Internal rechargeable battery	**$50**

PEC
MOTOFOCUS
MOTOTRAK V
JMI
CCD
12VDC
ON/OFF

NEW!!!

MOTODEC Declination motors for dozens of telescope models. Most have variable speed adjustment and clutch.
Starting from $89.95($3)

NEW! The **MOTOTRAK V** brings features to after-market drive correctors which, until recently, were not available in even the most advanced amateur instruments. Features such as the King drive rate and Periodic Error Correction (PEC*). Of course, the **MOTOTRAK V** also has all the features for which our units have been called the "Cadillac of drive correctors" — dual-axis correction, multiple drive rates, focus motor control, and CCD-autoguider jack, to name a few.

*The term "PEC" is licensed from Tangent Instruments.

NEW MEADE® ADVANCED PRODUCTS AT LUMICON

"What an astounding combination of high performance and low price!" Jack Marling, Ph.D., owner of LUMICON

TOLL-FREE ORDER LINE 1-800-767-9576

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MEADE APOCHROMAT ED REFRACTORS

7" f/9 Apochromat
Only $5495

7" IN STOCK!

Meade 6" f/9 Model 152ED Refractor shown with #1697 Computer.

See the Meade ad in this magazine for full specifications and product descriptions. ED = Extremely low dispersion glass which yields color-free virtually perfect images. PPEC = Permanent Periodic Error Correction "Smart Drive."

Model 102 ED 4" f/9 Apochromat & mount (add $105 P&S)	**$2195**
Model 127 ED 5" f/9 Apochromat & mount (add $125 P&S)	**$2795**
Model 152 ED 6" f/9 Apochromat & mount (add $185 P&S)	**$4495**
Model 178 ED 7" f/9 Apochromat & mount (add $215 P&S)	**$5495**
Medium format adapters ..... Mamiya 645, **$98;** Pentax 6X7,	**$98**
Med. format EASY-GUIDER™: Mamiya 645, **$298;** Pentax 6X7,	**$298**

DRIVE SYSTEMS

#1664 Electronic Drive with PPEC & 2X, 32X slewing system	**$375**
#1697 Computer Drive, 747 object computer memory, automatic slewing to desired object	**$695**
8,000 Object CNGC Library .. **$99** Polar alignment finder ..	**$99**

OPTICAL TUBE ASSEMBLIES (OTA)

Model 102 ED/OTA 4" f/9 OTA only (add $55 P&S)	**$1045**
Model 127 ED/APO-OTA 5" f/9 OTA only (add $60 P&S)	**$1595**
Model 152 ED/APO-OTA 6" f/9 OTA only (add $100 P&S)	**$2295**
Model 178 ED/APO-OTA 7" f/9 OTA only (add $120 P&S)	**$3250**
Cradle ring assem. 4" (4½" OD tube) **$135;** 5" (5½" OD tube)	**$145**
Cradle ring assem. 6" (7" OD tube) **$169;** 7" (8" OD tube)	**$219**

EQUATORIAL MOUNTS

LXD 600 mount and standard field tripod (add $60 P&S)	**$1350**
LXD 700 mount and giant field tripod (add $100 P&S)	**$2250**

NOTE: Add the indicated packing and shipping (P&S) costs to each telescope for insured UPS shipment to your door.

MEADE SERIES 4000 PREMIUM EYEPIECES

6.4, 9.4, 12.4, 15, 20, 26mm Plossl	**$88**
32mm, 40mm Super Plossl	**$110**
56mm Super Plossl (2") ***THE BEST****	**$230**
13.8mm Super Wide Angle	**$160**
18mm Super Wide Angle	**$170**
24.5mm Super Wide Angle	**$199**
32mm Super Wide Angle (2")	**$280**
40mm Super Wide Angle (2")	**$340**
4.7mm Ultra Wide Angle	**$180**
6.7mm Ultra Wide Angle	**$219**
8.8mm Ultra Wide Angle (1¼/2")	**$270**
14mm Ultra Wide Angle (1¼/2")	**$329**

Shipping charges of 1-2% are extra.

**Plossl test, "SKY & TELESCOPE," p490-492, May 1988*

NEW MEADE 12" LX200 SCHMIDT-CASSEGRAINS

8" LX200
$2295

12" LX200 $3995

NEW Meade 8" LX200 Telescopes

See the Meade ad in this magazine for full specifications & details. **LX100 Drive**, 2X, 32X speed control with PPEC (Permanent Periodic Error Correction "Smart Drive") & dual-axis hand controller. **LX200 Drive**, Full electronic control with PPEC, 747 object computer memory and automatic computer controlled slewing to desired object. *NOTE:* A wedge is **not** needed for visual observing with the LX200 Drive. Select f/10 or f/6.3 (no extra charge) for your Schmidt-Cassegrain.

8" LX100 Schmidt-Cassegrain with wedge (add $105 P&S)	**$1995**
8" LX200 Schmidt-Cassegrain with computer (add $105 P&S)	**$2295**
Wedge for photographing with 8" LX200	**$110**
10" LX100 Schmidt-Cassegrain w/super wedge (add $145 P&S)	**$2895**
10" LX200 Schmidt-Cassegrain with computer (add $145 P&S)	**$2895**
NEW! 12" LX200 (f/10 only) with computer (add $215 P&S)	**$3995**
Super Wedge for photography with 10" or 12" LX200	**$395**
8,000 Object CNGC Library (Version 2.5 software)	**$99**
Library Option 1: 10,600 NGC, Messier, IC objects (Ver. 3.2 only)	**$99**
Library Option 2: 64,350 celestial objects (Version 3.2 only)	**$149**

OTHER SCHMIDT-CASSEGRAINS

Meade 2045D 4" f/10 with motor drive (add $40 P&S)	**$699**
Meade 2080B 8" f/10 with tripod, wedge, MCOG (add $85 P&S)	**$1149**
NEW! Model 2120B 10" f/10 w/wedge, tripod, MCOG (add $125)	**$1449**

PHOTOGRAPHY ACCESSORIES

LUMICON Cassegrain EASY-GUIDER 4", 8" only, f/6 or f/10	**$225**
LUMICON Giant EASY-GUIDER for 10" or 12" f/4-f/10 operation	**$395**

MEADE STARFINDERS

8" f/6
$699*

New 8" f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions and technical specifications for 6" to 16" Starfinders. These are complete telescope systems with motor drive, mount, finderscope and 25mm (=48X) eyepiece.

6" f/8 Starfinder 6(add $65 P&S)	**$599**
8" f/6 Starfinder 8 (add $75 P&S)	**$699**
10" f/4.5 Starfinder 10 (add $90 P&S)	**$799**
16" f/4.5 Starfinder 16 (ship. freight COD)	**$2195**

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated shipping charge to the price. LUMICON showroom prices are $99 higher.

ACCESSORIES

LUMICON carries the full line of Meade accessories. See the Meade ad in this magazine for detailed prices and descriptions.

LUMICON Single axis drive corrector	**$99**
LUMICON DX200 Dual-axis drive cor.	**$249**
Meade 47M Dual-axis drive corrector	**$450**
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack	**$299**

LUMICON® SKY VECTOR™

Higher Performance — Lower Price

LOW PRICE—from $399

LUMICON SKY VECTOR FEATURES:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital decl. readout to 10 arc-min.
- 4000 pulse (0.09° accuracy) encoders
- Polar alignment ***not required!***
- Motor drive ***not required!***
- Just sight two stars to align!
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- **No need** to enter latitude, longitude, etc.

SKY VECTOR I™ $399

NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ $499

IMPROVED — Planets, Over 3,700 Objects! With size, magnitude and full visual description.

NGC SKY VECTOR™ $699

IMPROVED!—5500 Additions / Corrections

NGC-Sky Vector
OFF ON
DIM
MODE
ENTER
UP
DOWN
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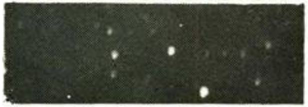
Improved NGC SKY VECTOR with over 12,000 object memory including the planets, complete, corrected RNGC catalogue, IC catalogue, P&K planetary catalogue, & much more!

Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR



Coma 1 inch off-axis 17½" f/4.5

Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2" EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8".

LUMICON 48mm Coma Corrector/Field Flattener Lens	**$285.00**
LUMICON 2" EASY-GUIDER	**$169.50**
2" EASY-GUIDER (Mamiya 645)	**$199.50**
2" Adapter for Pentax 6X7	**$129.00**
2" Adapter for Hasselblad	**$229.00**
2" Adapter for Bronica SQ-A	**$175.00**
2" Extension for viewing	**$26.00**

2" DELUXE BARLOW

1.8x Multiplier Lens (2" Barlow)

LUMICON 1.8x Multiplier Lens (2" Barlow) **$235.00**

LUMICON ACCESSORIES

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550 (510) 447-9570 FAX (510) 447-9589

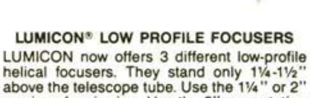
LARGE UV/DUST SEAL

Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

Deep-Sky Filter/Dust Seal for C-8, 2080	**$119.50**
UV/Dust Deal for Celestron C-8	**$39.00**
UV/Dust Seal for Meade 2080, 2045	**$39.00**
UV/Dust Seal (large) for Meade 2120	**$89.50**
UV/Dust Seal for Celestron-11, -14	**$89.50**

LOW PROFILE FOCUSERS
New! Thread-on for Odyssey

FROM $59.50



LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape! Coulter Odyssey (thread-on installation), Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD.

LUMICON 1¼" Helical Focuser	**$59.50**
LUMICON 2" Helical Focuser 1½" high	**$65.00**
LUMICON Non-rotating Helical Focuser	**$129.00**
2" Astro Systems focuser, only 2" high	**$139.00**
3 handles for non-rotating focuser	**$12.95**
2"/1¼" **adapter** w/48mm filter threads	**$20.00**
2" **LUMICON EASY-GUIDER**	**$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼" 50mm Finderscope **$59.50**, right-angle	**$59.50**
1¼" straight-thru 80mm SUPER-FINDER	**$169**
1¼" right-angle 80mm SUPER-FINDER	**$179.50**
1¼" right-angle version, w/star diagonal	**$209**
25mm Cross-hair 1¼" eyepiece (12X)	**$39**
Large mounting rings for 80mm Finder	**$55**
1¼" Star Diagonal **$39**, Mounting Brackets,	**$39.50**
1¼" 45° diagonal for correct left-right views	**$52.44**

LOTS OF ADAPTERS

2" adapter for C-8, Meade 2080, etc.	**$26.00**
2" adapter for C-80, C-100 refractor	**$39.50**
2" adapter for C-70, C-80F, C-100F fluorite	**$39.50**
2" adapter for C-6, Comet Catcher, Meade 312	**$30.00**

EXTENSION TUBES

1" long 1¼" OD thread-in extension	**12.00**
2½" long extension (holds 1¼" filters)	**16.00**
4½" long extension for 1¼" eyepieces	**$25.00**
3" long extension for 2" eyepieces*	**$26.00**
2" long extension for 2" eyepieces*	**$26.00**

VIEWING ADAPTERS

2"/1¼" reducing bushing,threaded 48mm*	**$20.00**
2"/T-thread adapter, threaded 48mm*	**$25.00**
T-thread/1¼" adapter	**$25.00**
F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider	**$39.50**
Low profile star diagonal eyepiece holder	**$16.00**
Meade 2" Diagonal/Giant Easy-Guider	**$39.50**

**Threaded to hold 48mm filters.*

Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery, competitive prices

LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH

Galaxy M81 in Ursa Major. 75 minute exposure by Tony Hallas and Daphne Mount using hypered 2415 film and a LUMICON Giant Easy-Guider and C-14 telescope at f/7.5. Tony said, *If it wasn't for your accessories, these astrophotos wouldn't have been possible.*

"I'd Pick The TELE VUE™"

40mm Wide-Field Test, "Astronomy," Aug. 1990, p. 90

NEW! Genesis-SDF 4" f/5.4 SD-fluorite	**$1885**
Pronto 70mm f/6.8 apochromat w/2" diagonal	**$825**
Pronto 70mm f/6.8 w/45° erecting prism	**$725**
Complete Equatorial Mount	**$795**
Motor Drive for above mount	**$239**
7.4, 10.4, 13, 17, 21, 26mm Plossl 50°	**$79**
1.8x or 2.5x Tele Vue Barlow Lens	**$89**
2" Giant Barlow - 2x	**$189**
32mm Plossl, widest true field in 1¼"	**$109**
55mm 2" Plossl, widest possible field	**$219**
15mm Wide-Field, 1¼" eyepiece, 65°	**$135**
19mm Wide-Field, 1¼" eyepiece, 65°	**$145**
24mm Wide-Field, "Rich-Field!" 65°	**$169**
32mm Wide-Field, 2" eyepiece, 65°	**$239**
40mm Wide-Field, "Rich-Field!" 65°	**$299**
4.8mm Nagler, 82° field, 1¼" eyepiece	**$149**
7mm Nagler, 1¼" eyepiece, 82° field	**$189**
9mm Nagler, 82° field, 1¼" or 2"	**$219**
13mm Nagler, 82° field, 1¼" or 2"	**$249**
12mm Nagler, Type II, 82°, 1¼"/2"	**$249**
16mm Nagler, Type II, 82°, 1¼"/2"	**$289**
20mm Nagler, Type II, 82°, 2" only	**$340**
1¼" Paracorr Visual Coma Corrector	**$159**
2" Paracorr Visual Coma Corrector	**$249**
NEW! 15mm Panoptic 1¼", 68° field	**$199**
NEW! 22mm Panoptic 1¼"/2", 68°	**$249**
NEW! 27mm Panoptic 2", 68° field	**$299**
NEW! 35mm Panoptic 2", 68° field	**$325**

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

LUMICON Adjust. Piggyback Mount **$59.50**
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	**H-Alpha**	**(MV)**
46, 48, 49mm	**$59.00**	**$49.00**
52, 55, 58, 62mm	**$69.00**	**$59.00**
67, 72, 77mm	**$79.00**	**$69.00**
82mm	**$89.00**	**N/A**

Hypered 2415 film, 36 exp .. **$10.95, $3/$29**

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Prices subject to change w/o notice.
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NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding up to an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32"	**$39.50**	1.52"	**$45.00**	1.83"	**$49.50**
2.14"	**$59.50**	2.60"	**$75.00**	3.10"	**$99.50**

ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror)	**$99.50**
2" (1.83" mirror)(see photo above)	**$159.00**

LUMICON FILTERS — BEST IN THE WORLD!

"The LUMICON OIII proved to be our favorite... It gave the greatest contrast gain."
ASTRONOMY February 1991

AMAZING OIII FILTER™

Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90-96% for both O-III lines at 496nm and 501nm.

"I CAN SEE THE VEIL NEBULA!"

Rich Zepernick saw the Veil Nebula for the very first time with a **LUMICON UHC Filter**. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*
Rich Zepernick, Cresskill, NJ

SEE THE HORSEHEAD!

Horsehead Nebula in Orion. This faint nebula is seen best with a LUMICON H-Beta Filter. Photo by J. Marling using a Deep-Sky Filter.

DEEP-SKY FILTER™

BEST for Astrophotography!

"Stunning is all I can say," says noted astrophotographer Jack Newton. Great for BOTH color and black and white photography.

BEST WIDE-BAND FILTER!

*"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for **reflection** nebulae."*
Astronomy, Feb. 1991

	Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces	**$59.50**
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces	**$79.50**
48mm LUMICON DEEP-SKY Filter (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	**$119.50**
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	**$119.50**
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)	**$299.50**
2" Rear Cell Filter, fits SCT's ... Deep-Sky, **$119.50** UHC, O-III, H-Beta,	**$199.50**
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces	**$99.50**
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	**$199.50**
Set of both premium **DEEP-SKY** and **UHC Filters** (Save 11%) ... 1¼" **$159.50**; 48mm	**$279.50**
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"** ... **$99.50, 48mm**	**$199.50**
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines ... **1¼" $99.50, 48mm**	**$199.50**
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm	**$6.95**
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece	**$16.00**
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece	**$20.00**

**Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

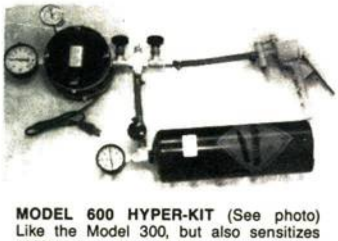
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**



MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$325**

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All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	**$169.50**
3X Relay Diagonal (see photo)	**$89.50**
Illuminated reticle eyepiece, pulsed	**$109.50**

Guider for Hasselblad **$350,** Mamiya 645 **$199**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$198,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

GIANT EASY-GUIDER™

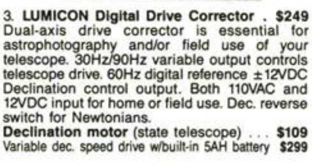
For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ..... **add $99.95**
Adapter for Hasselblad **$295,** Mamiya 645**$149**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

WHAT DO YOU NEED?

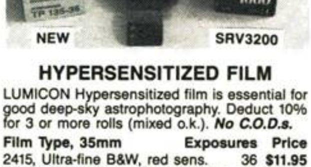
1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**



3. **LUMICON Digital Drive Corrector** . **$249**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 30Hz/90Hz variable output controls telescope drive. 60Hz digital reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Dec. reverse switch for Newtonians.

Declination motor (state telescope) ... **$109**
Variable dec. speed drive w/built-in 5AH battery **$299**



HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.). ***No C.O.D.s.***

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	**$11.95**
SR-G3200, fastest of all, color neg	24	**$13.95**
Kodak Ektar 1000 fast, fine grain	24	**$12.95**
Fuji HG400 fine grain color neg.	12	**$13.95**
3M 1000, fastest slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

telescope consists of three arrays of 24 photo detectors suspended 5 km deep in the ocean off Hawaii. It is being built by a research consortium of companies and universities from the United States, Japan, Germany, and Switzerland.

Only a few of the millions of neutrinos that speed through Earth every second react with matter in their path. When they do, secondary particles released in the reaction emit a blue flash of light that DUMAND can detect. Unlike other neutrino detectors, DUMAND can pinpoint the direction that the neutrino came from and help isolate its celestial source.

Supernova Electronic Highway

On March 29, 1993, thousands of backyard astronomers around the world learned about supernova 1993J in the spiral galaxy M81 in Ursa Major, discovered just hours earlier. The quick notification happened through the Internet computer network. The computer network also allowed dozens of amateurs and professionals to exchange brightness estimates of the supernova.

Michael Richmond, an astronomer at Princeton University, compiled the estimates and distributed them to other astronomers. Richmond says, "It worked great. It's important for us to get brightnesses during the early days of the supernova." The early days of SN 1993J were fascinating, as the supernova dimmed for a few days after discovery and then brightened again. Although astronomers suspected dips in brightness in past supernovae, this was the first one that had an early discovery combined with good follow-up observations to nail down the dip. Now researchers are pondering whether dips are normal for some types of supernovae.

Richmond adds, "If this supernova had gone off in 1983, we would have gotten perhaps one-fourth of the data that we did for SN 1993J. The electronic network made it easy for us to request data and easy for observers to reply." — *Robert Bunge*

Ices Contain Unexpected Hydrogen

Scott Sandford of NASA's Ames Research Center and his coworkers have found molecular hydrogen in the water-rich ices contained in the infrared emitting region called WL5, which lies in the Rho Ophiuchi cloud complex. Molecular hydrogen is the most abundant molecule in the universe, and astronomers find great quantities of it in gaseous form in molecular clouds. But they didn't expect to find it frozen in ice grains because it is so volatile or easily vaporized.

The researchers discovered in laboratory experiments that the molecular hydrogen probably doesn't freeze out into ice, but forms within the ice. Ultraviolet light from stars in the Rho Ophiuchi cloud breaks down water and methanol in the ice grains and forms molecular hydrogen.

"The great volatility of molecular hydrogen in ices," says Sanford,"may help explain why some comets are active at great distances from the Sun, distances at which water ices are too cold to be active."

Youngest Star?

The star called VLA 1623, which lies 500 light-years away in the Rho Ophiuchi A dust cloud, may be the youngest star ever seen by astronomers. Derek Ward-Thompson of Cambridge University and his team studied the star at millimeter wavelengths that lie between the infrared and radio parts of the spectrum. This enabled the researchers to peer through the cloud of dust and gas surrounding the star. They believe the star may be only 10,000 years old, making it a protostar, an object just starting to collapse into a star.

Yep, We're Here
GALILEO FINDS LIFE ON EARTH

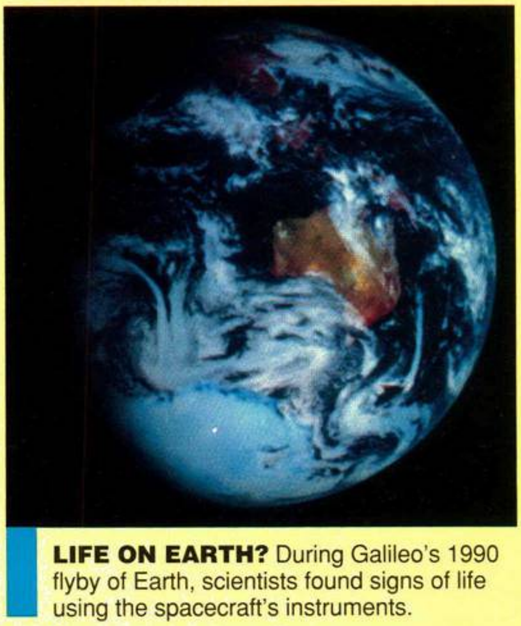
In December 1990, when Galileo made the first of its two swings past Earth on the way to Jupiter, a team of planetary scientists attempted to use the craft's instruments to answer an unusual question: Is there life on Earth? You'll be relieved to know there is and that Galileo found it.

The team, led by Carl Sagan of Cornell University, specifically looked for and found "such profound departures from equilibrium that the presence of life seems the most probable cause."

The strongest evidence is the high proportion of oxygen in Earth's atmosphere. Far too much exists for it to come from the breakup of water by solar ultraviolet light, the only plausible source for it apart from biological action. Galileo also detected methane in amounts far higher than a sterile world would have naturally. Although the camera did not image unambiguously any sign of a technological civilization on Earth, the plasma-wave experiment did detect AM radio transmissions.

"Most of the evidence uncovered by Galileo would have been discovered by a similar spacecraft as long ago as about 2 billion years," the scientists say — but note that the radio transmissions could not have been detected before this century.

Why bother? According to the scientists, the Galileo experiment made a unique test of the ability of a flyby spacecraft to detect life in the solar system at various stages of development. Because the researchers made no *a priori* assumptions — and used no special instruments beyond those aboard Galileo for other experiments — they feel that "negative results in spacecraft exploration of other planets thus have much wider application than merely to life-as-we-know-it."



NASA/JPL from W. Reid Thompson

LIFE ON EARTH? During Galileo's 1990 flyby of Earth, scientists found signs of life using the spacecraft's instruments.

READER'S EXCHANGE

ANNOUNCEMENT. Hunting for astronomy software for your Amiga or *Macintosh*? We have been doing the same and have collected a number of public domain and shareware disks available to others. Send SASE (58¢) for list; specify your computer brand. Contact Russell and Jan, Box 1646, Orange Park, FL 32067-1646

FOR SALE. Questar available for swap for state of the art computer, monitor, printer, etc. Please write full details. ISP, P.O. Box 100, Onancock, VA 23417.

WANTED. Small telescope for mother with five children. Should be in good working condition with instructions included. Needed for emotional therapy. Money limited, but faith abundant. Contact Candace Bergman, 204 Alalani St., Pukalani, Maui, HI 96768.

WANTED. Be generous, and help the children in our small private school astronomy class with the best of teaching aids: back issues of ASTRONOMY magazine. Any and all, few or many. Will refund postage. Contact David Moody, Pleasant View School, Ulster Park, NY 12487, (914) 339-6680.

WANTED. Adventurers to join me on road trip to 11/3/94 eclipse centerline. Contact Michael S. Pickel, P.O. Box 841396, Houston, TX 77284-1396

WANTED. Edmund Astroscan 2001. Contact Chris Ragaisis, 11657 Chesterfield Court, Apt. B, Reston, VA 22090-3520, (703) 904-1788, ragaisis@netcom.com

FOR SALE. ASTRONOMY (August 1973-July 1978) in very good condition; $75 or best offer. Contact Scott Bobo, 1138 Oakdale Road NE, Atlanta, GA 30307, (404) 881-7598.

TRADE. *Norton's 2000*, 18th Edition or *The Backyard Astronomer's Guide* by Dickinson and Dyer for *1000+ Field Guide* by Lorenzin. Contact E. H. Achenbach, 4067 Lake Eleanor Drive, Mount Dora, FL 32757, (904) 383-2450.

FOR SALE. Issus of ASTRONOMY in binders from 1978 to 1990. All in good condition, some wrinkling due to humid climate. Will ship. Make offer. Contact Roger, (707) 822-1735 evenings.

FOR SALE. Meade 10 inch LX200 SCT Telescope. Purchased new 12/93. All accessories included. Used three times — in perfect condition; $2,100. Contact 2125 SW 15th Ave., Cape Coral, FL 33991, (813) 458-1448.

WANTED. *Deep Sky* issues #15-19, will pay $20. Contact Tom McGowan, 651 Broad St., Weymouth, MA 02189, (617) 335-7552.

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Edmund's World Famous Astroscan® Telescope. The easiest to use and enjoy family telescope. #AU2001 $399

The Stargazers Choice

Reach out and explore the night sky. Unique award winning design allows you to cradle it in your arms or it glides smoothly and solidly into its table-top base. Highlights of this scope are its extra wide 3° field and its superb light-gathering ability with large 4 1/8" clear aperture to resolve panoramic vistas. Optional image erector adapts scope to view land objects. Focuses 25 feet to infinity. System is sealed to protect against dust and moisture and is permanently collimated at the factory.

Astroscan 2001: Includes telescope, base, 28mm RKE® eyepiece, finder sight, dust cap, carry strap, 36 page instruction book and our 36 page sky guide. A wide assortment of accessories are also available.

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Our moderately priced, three-element system outperforms designs using four or more optical elements. The exclusive design of the RKE® eyepiece family coupled with the quality of its optics admits more light, is free from false color and offers a sharply-focused, wide-field view.

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15mm #AU30,819
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28mm #AU30,787
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Caught in the Act of Forming

Disks surrounding young stars in the open cluster NGC 6611 in Serpens show that the cluster is still in the act of forming. The cluster, embedded in the emission region known as the Eagle Nebula (M16), is one of the brightest in the summer Milky Way. Although long known to backyard observers and studied by professionals, the cluster is only now revealing the first detailed look at how intermediate mass stars form. The research was carried out by astronomers Lynne Hillenbrand and Stephen Strom of the University of Massachusetts and Philip Massey and K. Michael Merrill of Kitt Peak National Observatory.

Stars with masses more than eight times the Sun's form too quickly to be observed as they are born. Not so the intermediate mass stars, those with three to eight times the mass of the Sun. Hillenbrand and her collaborators studied nearly 4,000 stars in their survey, the largest known group of intermediate mass stars in the process of forming.

As a star forms, it produces a disk of material around its center. The star then grows by accumulating material from this disk. Astronomers have observed many such disks around low-mass stars like the Sun, because these disks last as long as 10 million years. For intermediate mass stars, the lifetime of a disk may be less than a million years, making them relatively hard to find.

Hillenbrand and her colleagues found 27 stars with disks visible at optical wavelengths and observed many others in the infrared. Additionally, the astronomers found the cluster contains some Be stars that appear to be very young. These hot stars, with bright lines in their spectra, were long thought to be near the end of their lives. The finding opens up a new discussion over what Be stars are and how they fit into the scheme of stellar evolution.

CARA

KECK II's DOME NEARS COMPLETION on the top of Mauna Kea, next to its twin, Keck I, in this photo taken on November 1, 1993. Workers finished the shutter later that month and painted the dome in January. After months of installing, testing, and calibrating Keck I instruments, the first scheduled nights of observing also occurred in November. Astronomers used the high-resolution echelle spectrograph, built by Steve Vogt of the University of California at Santa Cruz, to look at spotted stars, observe distant quasars, study the rotation periods of stars in the Pleiades star cluster, search for evidence of brown dwarfs, and measure how much of the beryllium "ash" left over from the Big Bang stars contain.

THE EAGLE NEBULA hides a star cluster brimming with intermediate mass stars in the act of forming.

NOAO

Clementine Won't Replace Mars Observer

Don't look for the United States to launch a new mission to Mars this year. NASA has rejected plans to send a replacement for Mars Observer in 1994 due to a lack of funds and lingering unanswered questions about what went wrong with the spacecraft.

Shortly after Mars Observer fell silent last August, the Pentagon told NASA that they could build and launch a replacement for about $75 million. The spacecraft would have been based on Clementine 1, a craft built by the Pentagon's Ballistic Missile Defense Organization to test lightweight missile sensors. (See "The Moon-Miner's Daughter," February 1994.) As we went to press, Clementine 1 was scheduled for launch in January.

The Clementine craft offered by the Pentagon would have provided better images of the Martian surface from orbit than the Viking probes of the 1970s did, although they would have fallen short of the Mars Observer images. NASA is now studying the possibility of launching a Mars mission in 1996. ☐

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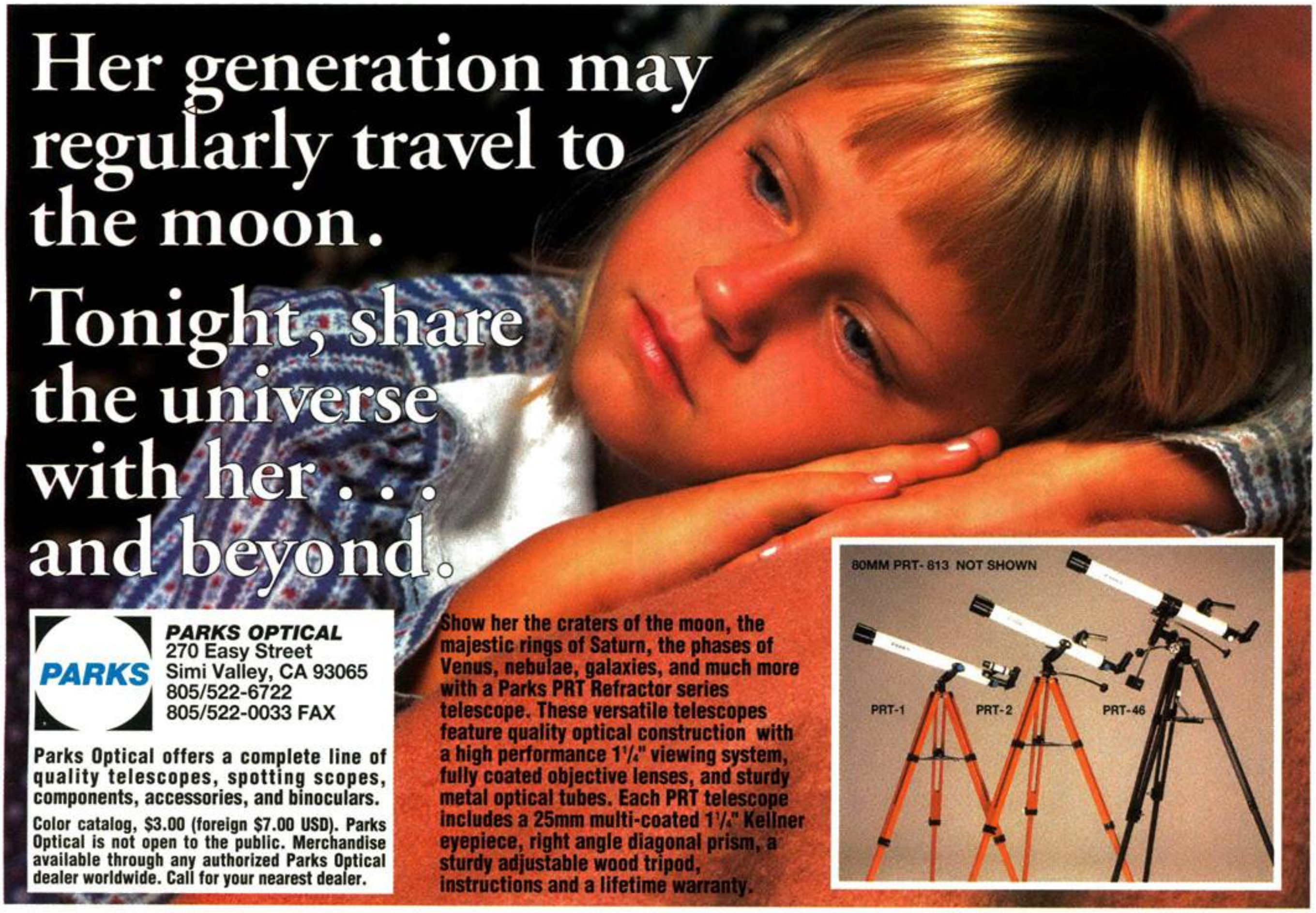
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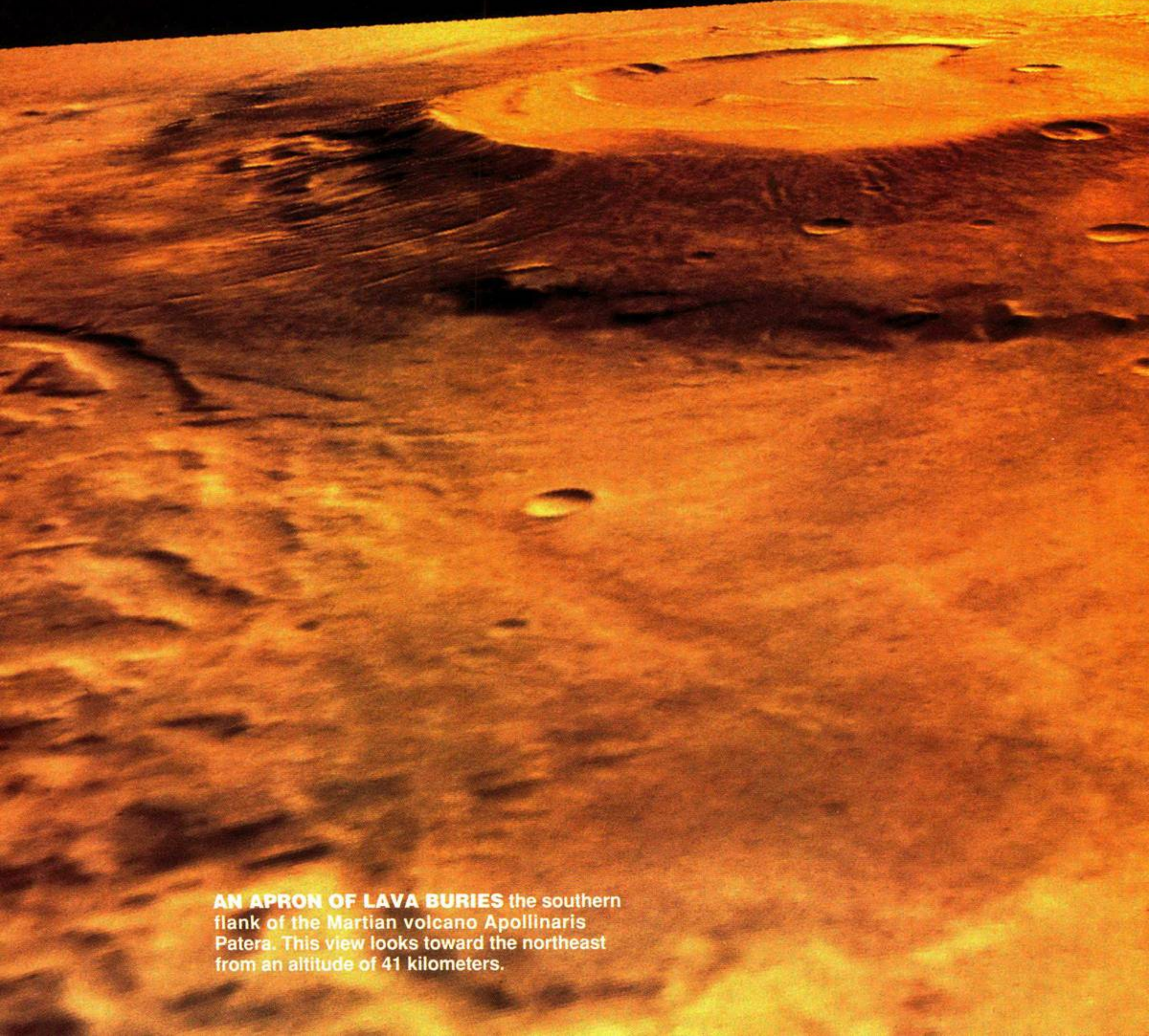
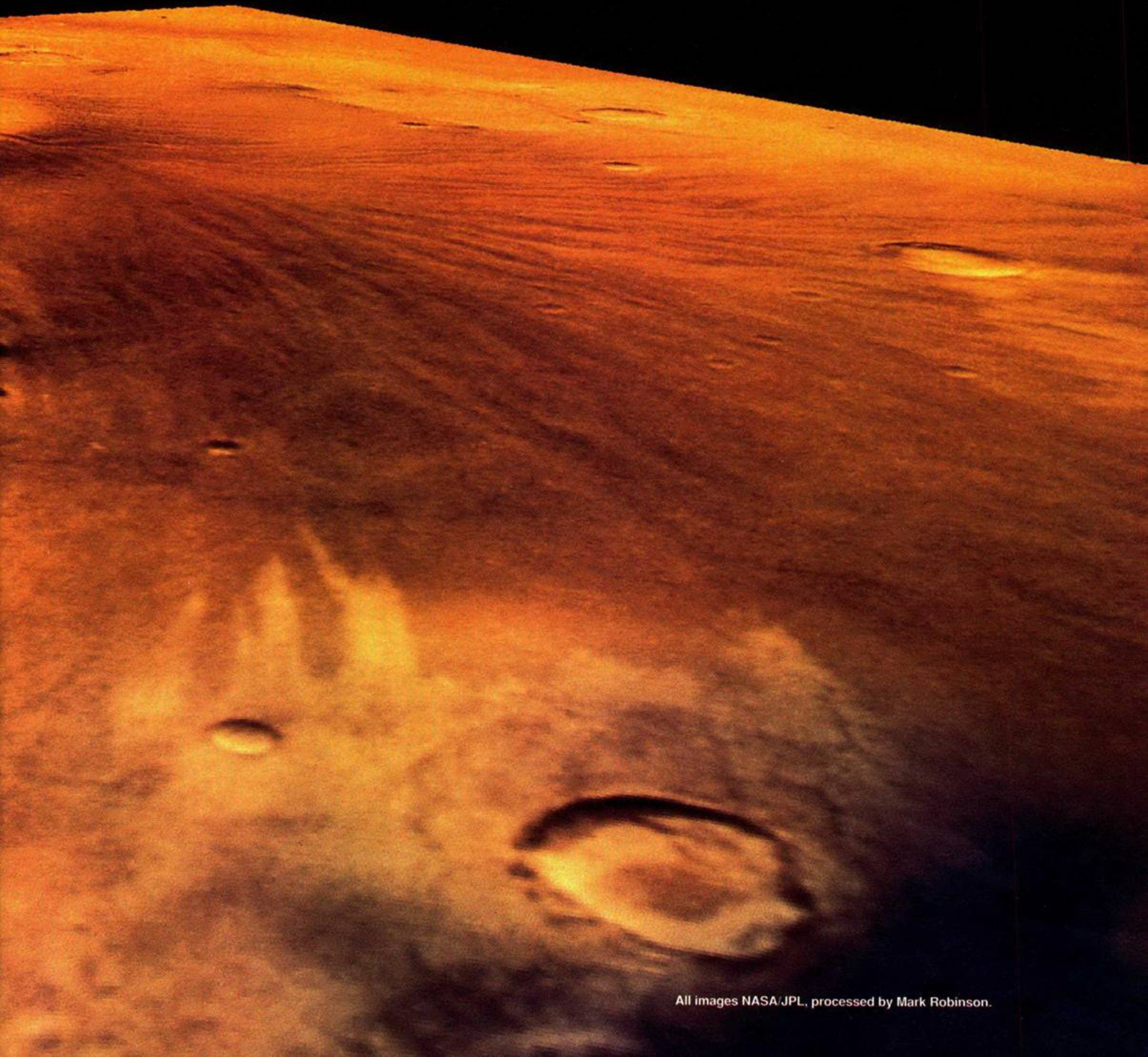


AN APRON OF LAVA BURIES the southern flank of the Martian volcano Apollinaris Patera. This view looks toward the northeast from an altitude of 41 kilometers.

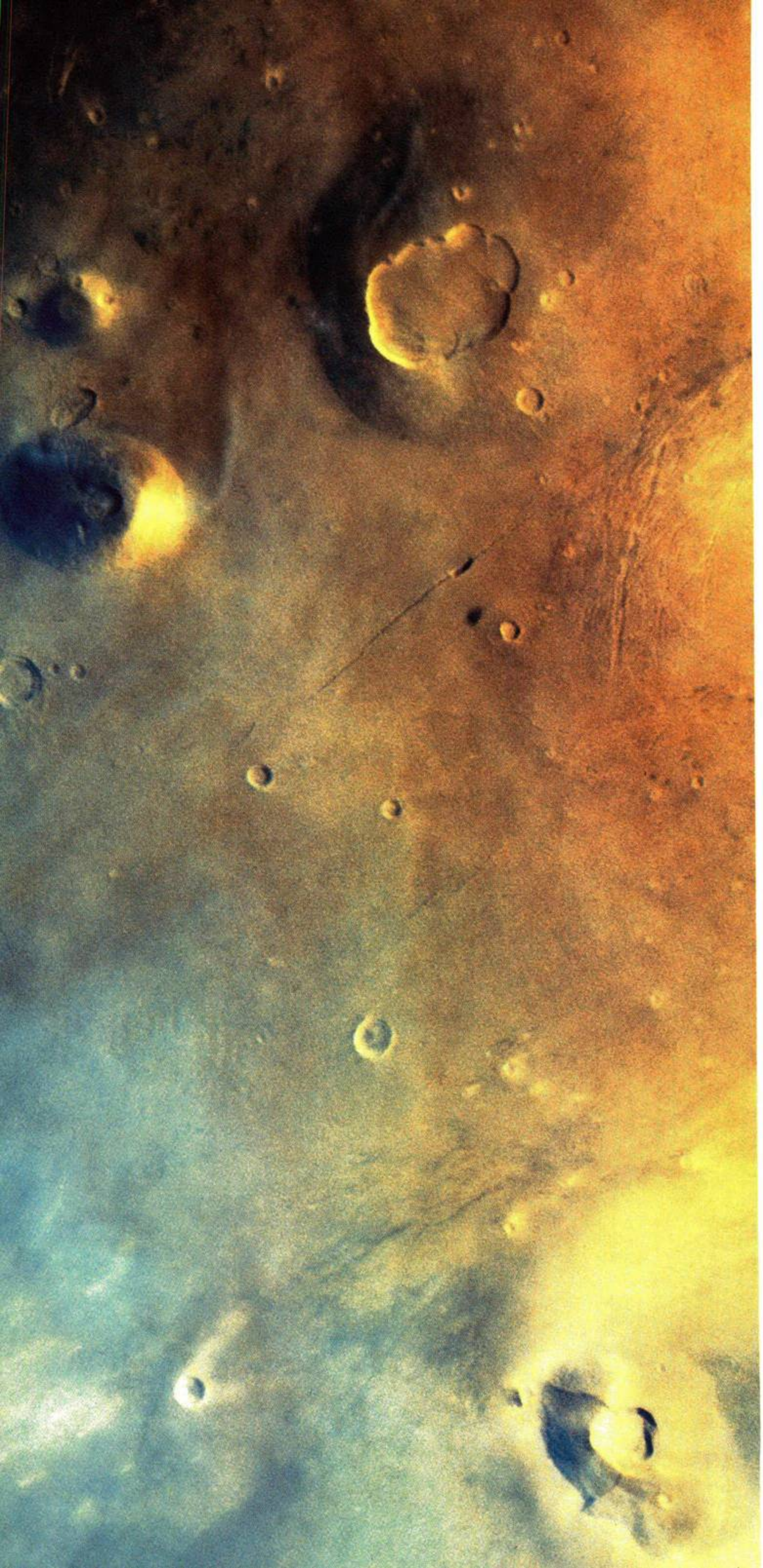
VOLCANOS ON MARS

There's a lot more to Martian volcanos than just the big ones in Tharsis.

by Mark Robinson



All images NASA/JPL, processed by Mark Robinson.



Volcanos interest planetary scientists a lot because they give us a peek at geological processes operating inside a planet. This is true of Earth and it's true of Mars as well. In fact, Mars is home to some of the largest volcanos in the solar system, including the awesome Olympus Mons, 600 kilometers across the base and 24 km high.

Spectacular features such as these can give planetary scientists many useful clues to the nature of volcanism on Mars and its history. But "small" Martian volcanos can be equally impressive — and there are a lot more of them. Actually, these volcanos are small only by Mars standards; they're often as big as the biggest on Earth.

For the past few years I have been using Viking orbiter images to study several small volcanos near Ascraeus Mons. (Ascraeus is the northernmost of the three big Tharsis volcanos that stand in a line east of Olympus Mons.) In particular, I've been investigating what geologists call eruption style. Basically, this means looking closely at the form of a volcano to deduce how it erupted and what forces drove it. For example, a key question is how much water and gas was involved. These substances exert a lot of control on an eruption and on what form the resulting structure will take.

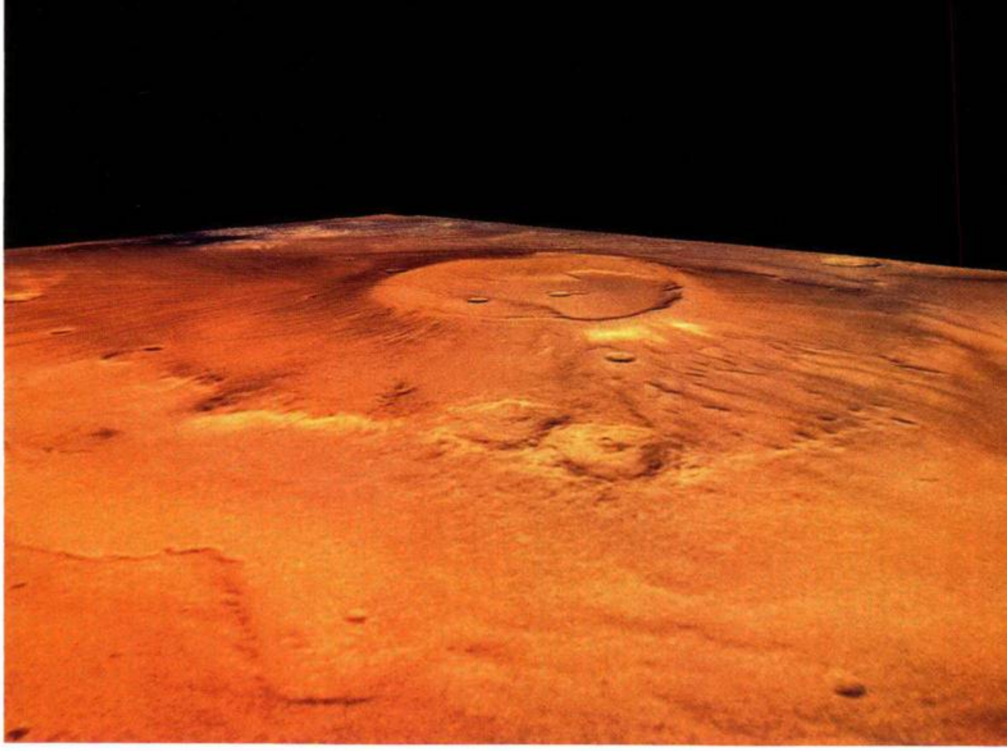
Scientists find that on Earth eruption styles fall into two general types: effusive and explosive. An effusive eruption is relatively quiet. It puts out flows of basaltic lava that move roughly as fast as you can walk. The lava is fluid because it is low in silica. The current eruptions at Kilauea volcano on the island of Hawaii are effusive.

An explosive eruption, on the other hand, is dramatic and usually dangerous for people nearby. It throws debris high into the air and can scatter it for hundreds of miles. While all explosive eruptions put out lava that is low in silica, they can

VARIATIONS ON A THEME. Four volcanos in Mars' Tharsis region display differences that point toward dissimilar origins. At bottom right is Tharsis Tholus; at top right, Uranius Patera. At top left are Uranius Tholus (the smaller *volcano*) and Ceraunius Tholus, which is about the size of the entire Big Island of Hawaii.

take on radically different forms, depending on how the lava interacts with water it encounters on the way to the surface or on how much gas it contains.

Some eruptions explode when a buildup of pressure within a volcano is suddenly released, for example by a landslide that abruptly opens up part of the volcano. The resulting explosion may destroy some or all of the volcano itself — witness Mount St. Helens in 1980. Another type of eruption explodes when rising lava touches water, either in the ground or in oceans or lakes, or as ice deposits. When the water flashes into steam, an explosion occurs. One of the most famous terrestrial examples was the explosive eruption in 1963 of Surtsey, off the coast of Iceland.



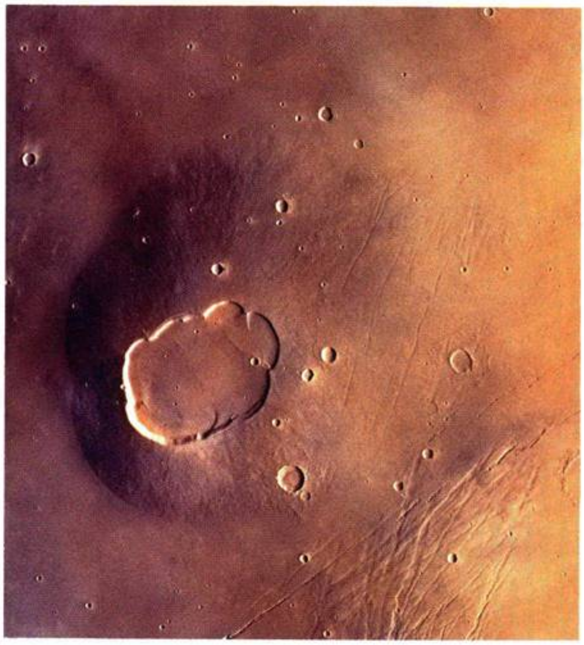
A CLIFF HALF A KILOMETER HIGH forms the edge of Apollinaris Patera's northeastern flank, with two large impact craters visible in the center. The view looks toward the southwest from an altitude of 41 km.

If scientists partly understand terrestrial volcanos, how these examples translate into Martian terms is a lot more obscure. For one thing, the chemical difference between high- and low-silica lavas on Earth doesn't seem to hold for Mars. All Martian lavas appear to be low-silica basalt, if we can believe the evidence of the SNC meteorites, which are thought to be pieces of Mars ejected by impacts.

The first step in studying Mars volcanism is to look closely at the details of a volcano using Viking images. For example, the 3-km-high volcano Uranius Patera (right) shows features similar to those on Hawaiian volcanos: lava flows, overlapping craters forming a caldera at the summit, and shallow slopes on the volcano's flanks. These point to an effusive eruption history for Uranius Patera that's similar to Hawaiian examples. Uranius Patera also contains about as much material as the whole Big Island of Hawaii, including the underwater part.

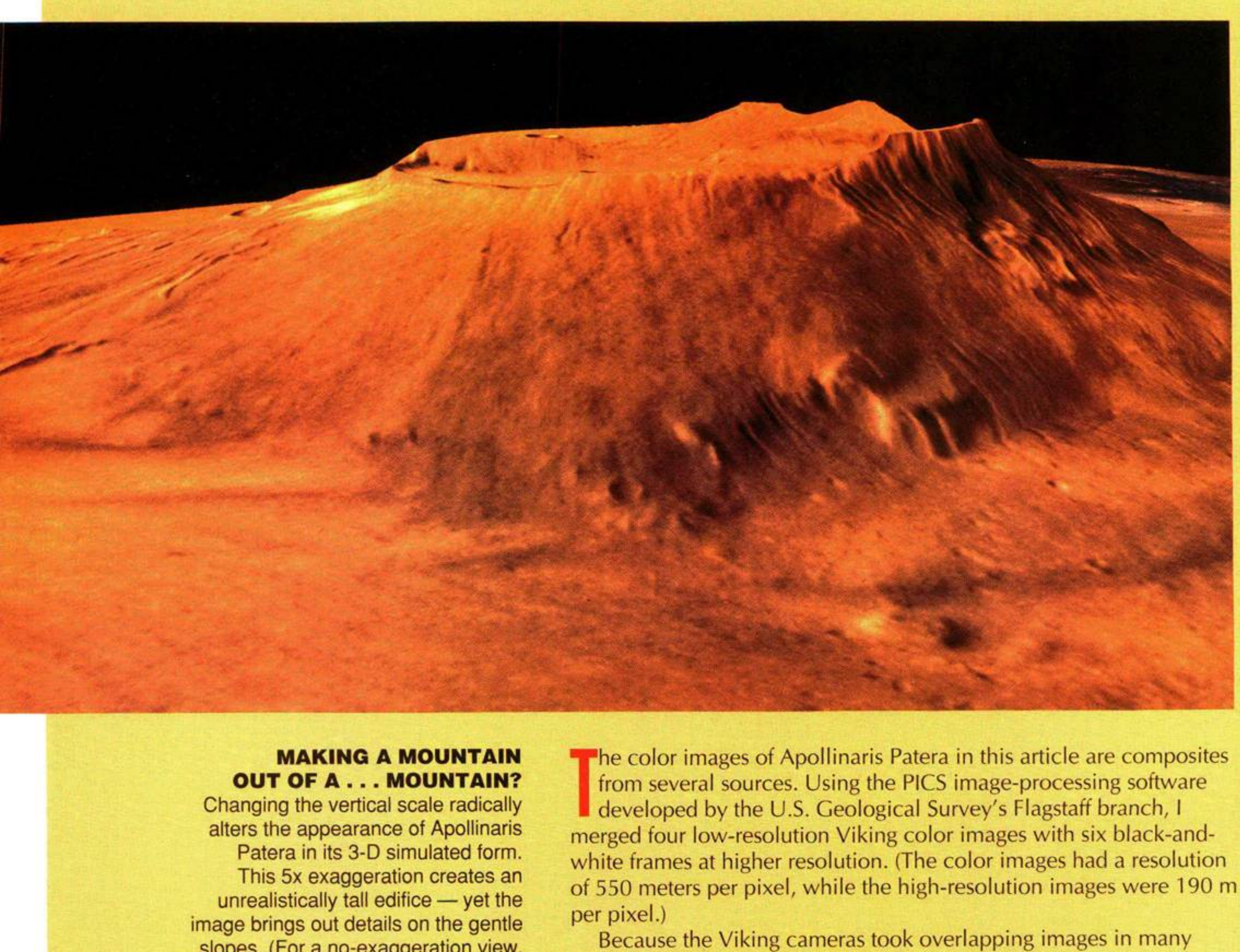
Ceraunius Tholus is something else again. This volcano, while about the same size as Uranius Patera, has a distinctly different morphology (see page 35). Its flanks are marked by incised valleys, not lava flows. These hint that the slopes of Ceraunius Tholus eroded easily, which is typical of ash deposits formed by explosive activity. In addition, the flanks of Ceraunius Tholus slope at 6° to 14°, steeper than the 3° to 8° of Uranius Patera, which also suggests that they formed by different processes. To the north of Ceraunius, the little volcano Uranius Tholus (not to be confused with the much larger Uranius Patera) has a morphology similar to that of Ceraunius Tholus; it, too, likely formed through explosive activity.

And then there's Tharsis Tholus. This volcano standing alone 700 km east of Ascraeus Mons can only be described as bizarre (pages 36-37). It's about 150 km across and 8 km high, much the same size as Ceraunius, but for unknown reasons its flanks divide into four major sectors. It looks broken, as if it were a clay model that somebody dropped. One possi-



LOOKING LIKE A BIG ROCK BLISTER, Uranius Patera has soft contours and gentle slopes. It probably grew as layer upon layer of fluid lava effused quietly outward from its central vent. When the lava drained away, the large summit caldera formed by collapse.

Getting a Perspective on Mars



MAKING A MOUNTAIN OUT OF A . . . MOUNTAIN?
Changing the vertical scale radically alters the appearance of Apollinaris Patera in its 3-D simulated form. This 5x exaggeration creates an unrealistically tall edifice — yet the image brings out details on the gentle slopes. (For a no-exaggeration view, see photo at top on the page opposite.)

The color images of Apollinaris Patera in this article are composites from several sources. Using the PICS image-processing software developed by the U.S. Geological Survey's Flagstaff branch, I merged four low-resolution Viking color images with six black-and-white frames at higher resolution. (The color images had a resolution of 550 meters per pixel, while the high-resolution images were 190 m per pixel.)

Because the Viking cameras took overlapping images in many places, I could view parts of Mars in stereo and derive topographic data for the third dimension — altitude. The computer used the stereo data to create a 3-D electronic model of the volcano. I then draped the detailed color image over the 3-D model.

It was then relatively simple to tell the computer where to view the volcano from, and it created the appropriate perspective view. It's as if you took one of those 3-D plastic maps of a national park, placed it on a table, and leaned over to snap a photo of it from this or that angle.

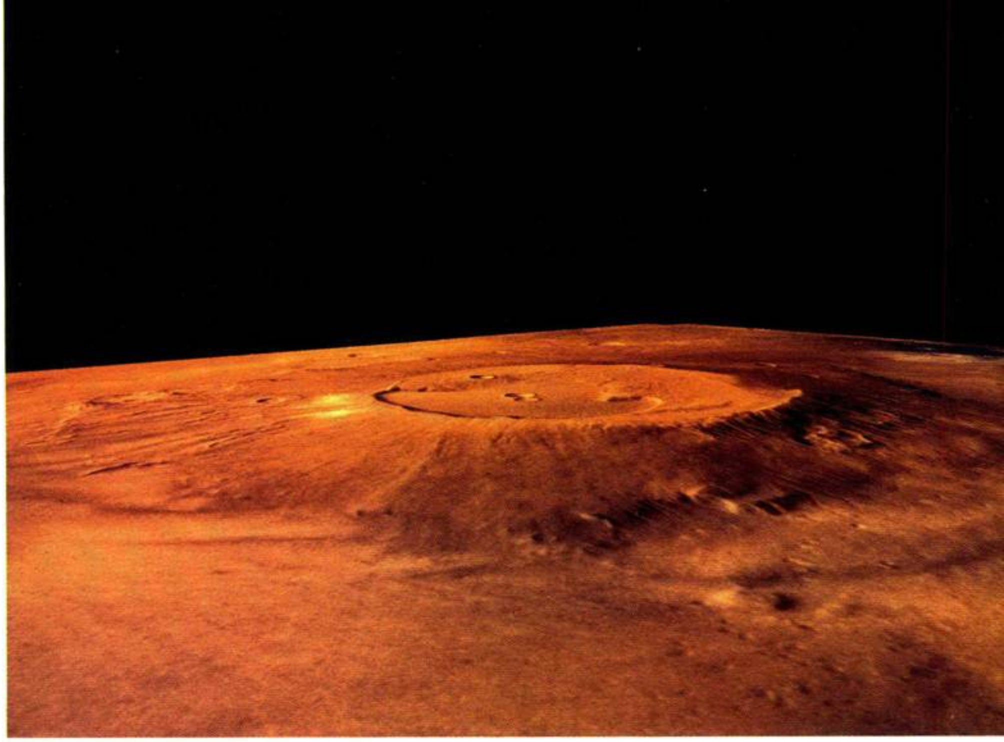
Unlike a plastic model, however, it's easy to change the vertical scale on the computer's topographic model. All you do is multiply the elevations by some exaggeration factor. Using a large factor can give some pretty garish effects (see above) but it's essential for studying regions with little topography and shallow slopes.

In the perspective views in this article, however, I applied no exaggeration to the vertical scale. The terrain looks just as it would out the window of a spaceship flying over Mars.

ble explanation is that the center of the volcano collapsed when the lava supply drained away. Another possibility is that big slumps may have carried off portions of the volcano's flanks, breaking its outline.

Not only is the overall shape of Tharsis Tholus distinctive, it also has an unusual caldera. The western side of the caldera has almost 5 km of topographic relief, twice that on the east. The west side also exhibits walls with gullies and ridges similar to the canyon walls of Valles Marineris.

Determining the origin of this enigmatic volcano isn't easy. Like the flanks of explosively formed Ceraunius Tholus, the flanks of Tharsis Tholus lack lava flows and have steep slopes. However, Tharsis Tholus doesn't have the distinctive, incised valleys seen on Ceraunius Tholus. For want of a better answer, planetary scientists are calling it dominantly explosive in origin, but the full explanation is far from known.



REPEATED ERUPTIONS BUILT the double caldera on the summit of Apollinaris Patera. The inner caldera has flat-lying lava that cuts into the sloping outer caldera walls. The view looks southeast from an altitude of 32 km; and uses no vertical exaggeration.

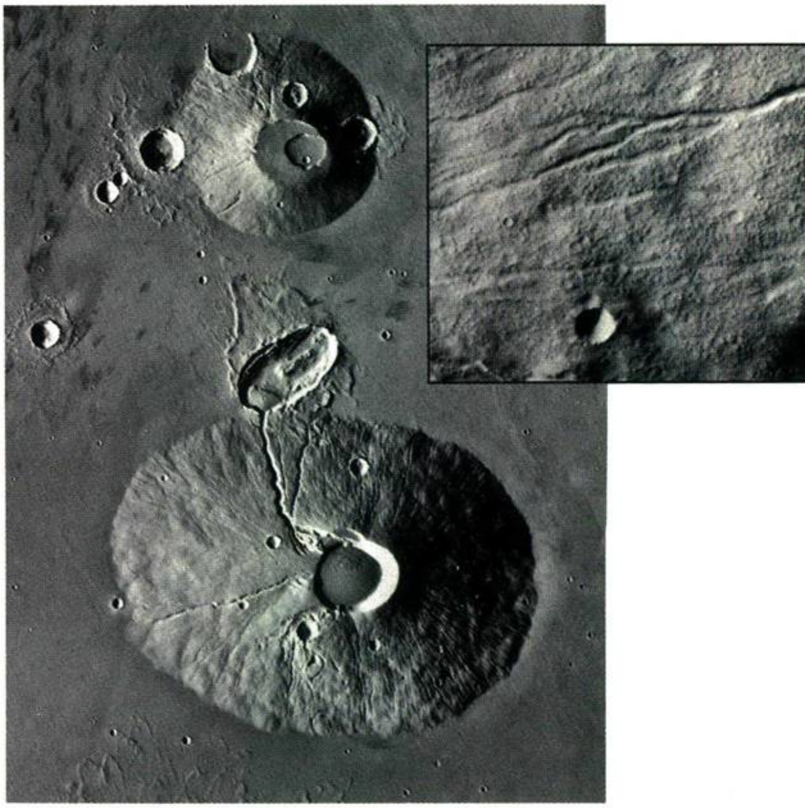
The most interesting volcano on Mars, however, may be Apollinaris Patera (shown on pages 30-31). This volcano stands relatively alone to the southeast of the volcanic field in Elysium, thousands of kilometers west of the Tharsis region. Apollinaris Patera reaches an altitude of about 5 km from a base roughly 240 km across.

This volcano has features that resemble those of both Uranius Patera (effusive in type) and Ceraunius Tholus (explosive). The main part of the volcano has incised valleys similar to those on Ceraunius Tholus, which suggests that its flanks are ash deposits laid down by explosive eruptions. Large landslide scars on the western flanks also argue for a weakly adherent material such as volcanic ash (see page 37).

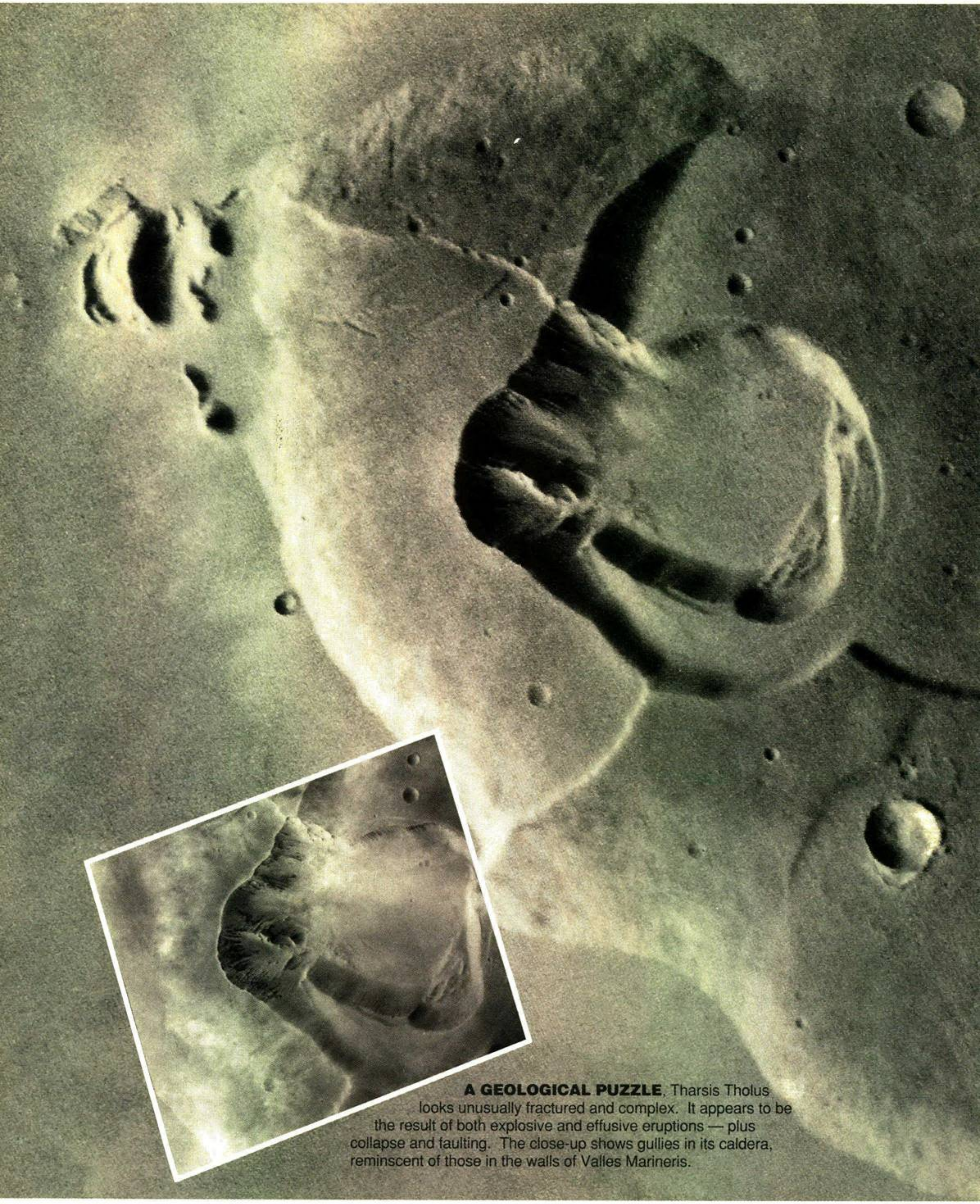
But explosions don't tell the whole story. The huge distinctive fan on the southern flank appears to have flowed out of the caldera. The best explanation for the fan is effusive activity — a relatively quiet lava eruption that flowed and flowed and flowed until it buried much of the south face of the volcano. What's the bottom line? If you roll all the features together, it looks like explosive eruptions dominated the early history of Apollinaris Patera while effusive activity controlled its later stages.

Understanding the nature of Apollinaris Patera's early explosive activity is important for Mars scientists. Did the explosions occur when gases dissolved in the lava escaped rapidly? Or did the ascending lava run into some body of water, either at the surface or in the ground? In the latter case, it would take a huge amount of water to produce a volcano as large as Apollinaris Patera.

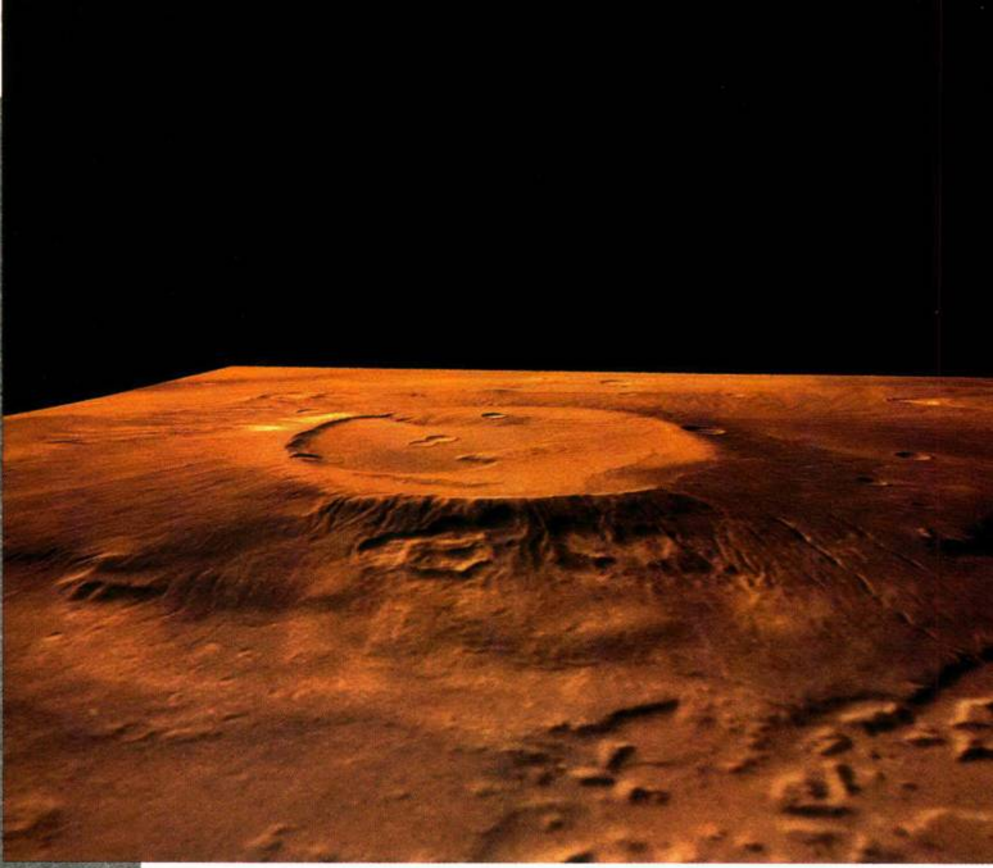
Does this volcano, then, give us a glimpse at early Mars? That's hard to say. And unfortunately the question will have to remain unanswered until future Mars missions gather better data and more images at higher resolution.



STEEP SLOPES AND CARVED VALLEYS BETRAY a probable explosive origin for Ceraunius Tholus (bottom) and the smaller Uranius Tholus. The close-up image (inset) shows some of the valleys carved into the soft flanks of Ceraunius.



A GEOLOGICAL PUZZLE, Tharsis Tholus looks unusually fractured and complex. It appears to be the result of both explosive and effusive eruptions — plus collapse and faulting. The close-up shows gullies in its caldera, reminiscent of those in the walls of Valles Marineris.



THE WESTERN FLANK COLLAPSED on Apollinaris Patera and left a blocky, broken surface behind. Erosion of this kind points to the volcano's flank being composed of ash deposited in repeated explosions. The view looks almost due east from an altitude of 41 km.

Having studied these volcanos, it strikes me that both explosive and effusive activity were important in forming Martian volcanos. Scientists, however, tend to focus on explosive eruptions because these have the power to put large amounts of gases, water vapor, and dust into the Martian atmosphere. While Mars has no volcanic activity today, at one time the active, explosive eruptions probably had a strong effect on the planet's climate. For comparison, the recent eruptions of Mt. Pinatubo, a small volcano in the Philippine Islands, caused a drop in temperature of about 1° Celsius in the Northern Hemisphere and half that in the Southern. If we can determine the global extent of the explosive eruptions that took place on Mars — and learn when they occurred — we'll have a much better understanding of the early Martian climate.

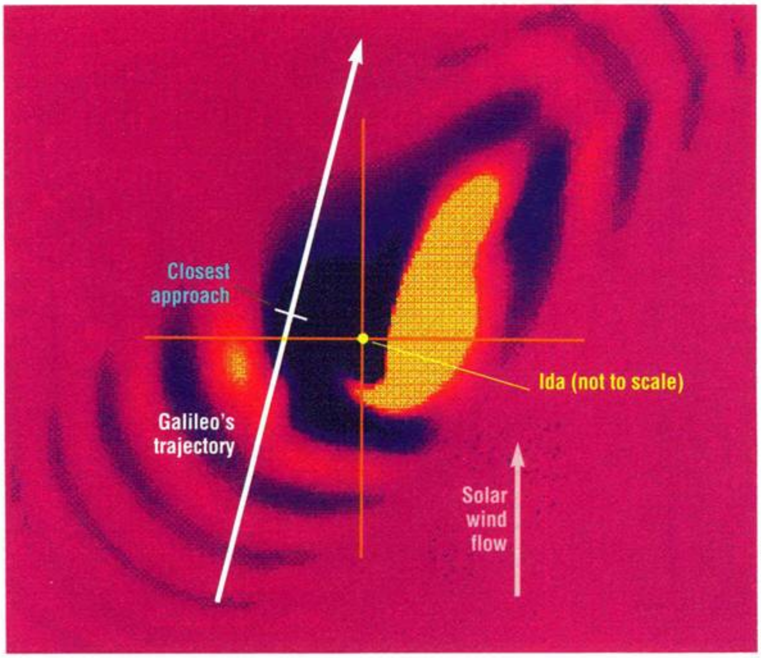
The late, lamented Mars Observer was supposed to get the data to do this. Its failure was intensely frustrating, but NASA's Mars Environmental Survey (MESUR) mission — plus the Russian Mars '94 and '96 missions — should take us back to Mars in the coming years and help unravel these and other problems regarding Martian volcanic activity. □

Mark Robinson, a recent graduate of the University of Hawaii, is a planetary scientist in Flagstaff, Arizona. His last ASTRONOMY article was "Surveying the Scars of Ancient Martian Floods" in October 1989.

Here's Looking at Ida

From a cratered surface to a magnetic field, Galileo's flight past asteroid Ida gave planetary scientists a number of surprises.

by Robert Burnham



M. Kivelson/UCLA

WHISTLING IN THE WIND — Ida's magnetic field disturbed the flow of the solar wind, producing radio waves called whistlers.

As Galileo headed for Jupiter last August, it flew past asteroid 243 Ida. When scientists got their first look at Ida, they received a shock.

Ida is *old*. Maybe 2 billion years old. And that's a surprise because scientists had expected it to be about 10 times younger (roughly as old as Gaspra, the first asteroid Galileo encountered). From studying the orbits and compositions of both, scientists had thought that Gaspra and Ida belonged to the Koronis asteroid family. This family is believed to contain the remnants of a larger body that broke apart about 200 million years ago (see "All in the Family," February 1993).

Gaspra's lightly cratered surface fit that age comfortably, but Ida's rubbly surface is too cratered to be that young. What's the solution? No one knows, but one possibility is that Ida may be an interloper among the Koronis family. A less comfortable idea is that scientists don't really understand the Koronis family.

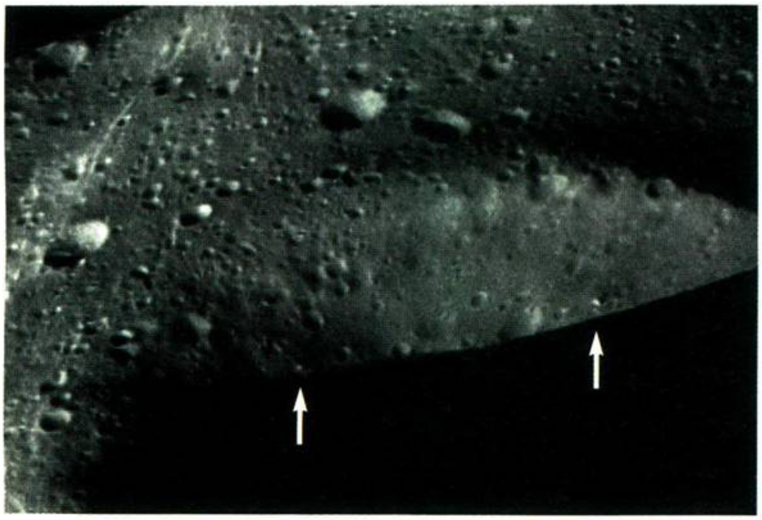
Ida's surface resembles the Moon's. Pore over the image and you'll find craters of every size, right down to the limit of the camera's resolution. At the other end of the size spectrum, researchers see huge, now-incomplete crater walls defining Ida's irregular outline. Highly magnified views show a few bright bumps that may be boulders (see left, below). And several dark-floored craters stand in a cluster near one limb. Did these punch through a surface layer to reveal dark "bedrock"? If so, why don't other craters have dark floors?

Lots of questions, few answers. This spring, scientists will read off the full set of encounter data from Galileo's tape recorder, which has to trickle data back at a slow rate through the craft's low-gain antenna. These data may settle at least some of the questions.

Not all of Galileo's findings at Ida involved geology. Another big result is that, like Gaspra, Ida affects the magnetic field of the solar wind sweeping past it (see above). Magnetometer team leader Margaret Kivelson of UCLA says this shows Ida probably has a magnetic field of some kind. That result raises the possibility that many asteroids — perhaps even most — do as well.

What's next? For Galileo — it's watching the nuclei of Comet Shoemaker-Levy 9 hit Jupiter this July. For asteroids — the next look will come this August (see "The Moon-Miner's Daughter, February 1994). This is when Clementine will fly past 1620 Geographos at less than 100 kilometers' distance. □

OLD AND CRATER-PITTED, Ida offered a marked contrast to Gaspra, Galileo's first asteroid. Bright bumps (arrows, below) may be 100-meter boulders ejected during impacts.



An Infrared View of Our Universe

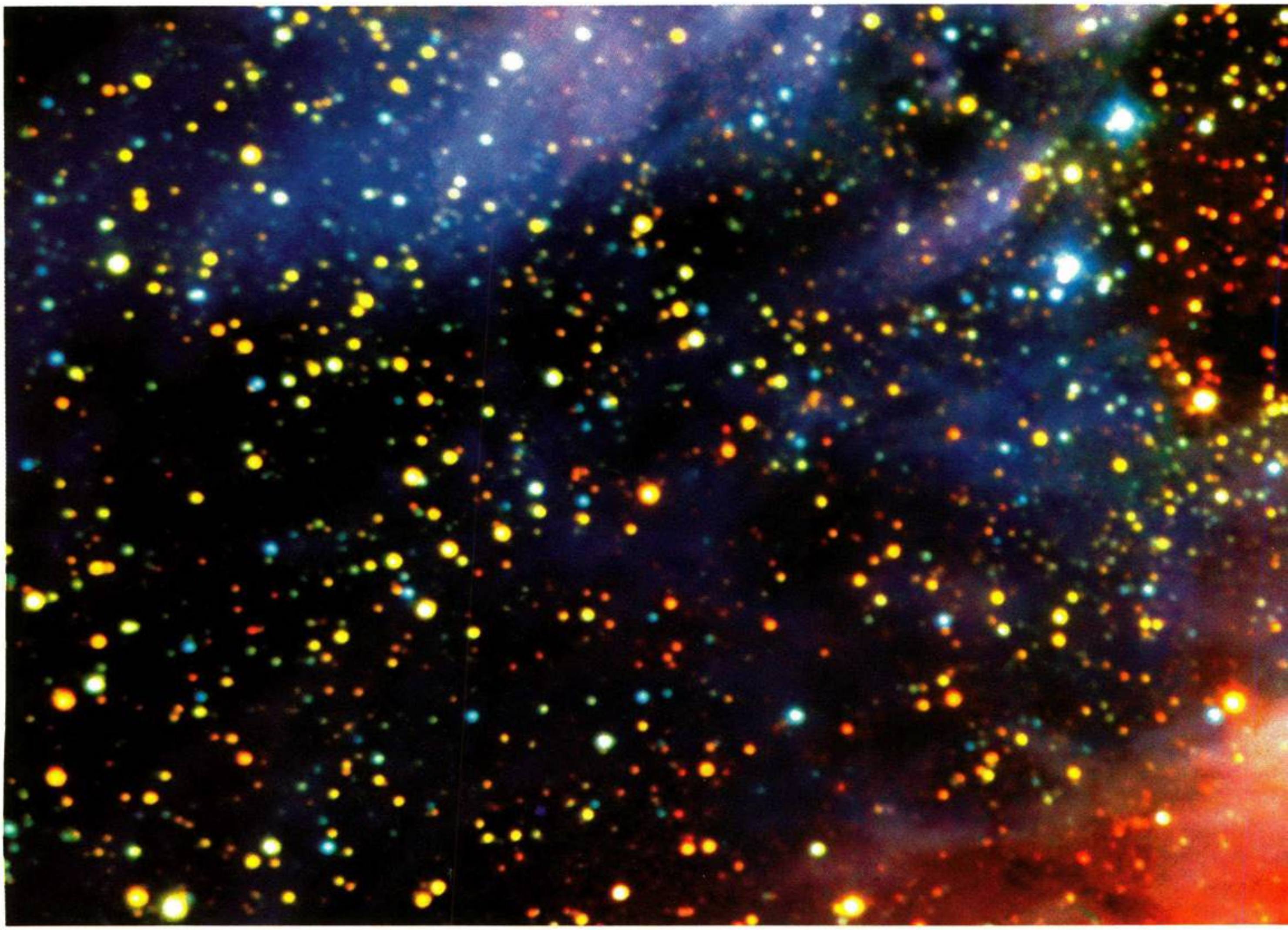
by Ian Gatley

Ten years ago you could easily tell which were the infrared images at an astronomy conference: They were the crude ones, compared with their optical counterparts. An astronomer "imaging" an object spent all night scanning the telescope's light beam back-and-forth over a single, relatively insensitive detector. The researcher then plotted these measurements one by one to create a primitive map of infrared brightness. Even early infrared cameras provided too small a field of view. Researchers had to tape together lots of exposures of small regions to make an image of the entire object. As recently as five years ago, pictures made in this crude way caused loud gasps at astronomy meetings as everyone admired these wonderful images.

But technology has progressed. Researchers have developed new detectors with greater sensitivity to infrared radiation and recently have produced large arrays that make imaging a simple task instead of a time-consuming chore. These arrays let astronomers probe regions of star formation, view the complex shells of gas cast off by dying stars, and more easily see structures in galaxies.

Why worry about imaging in the infrared anyway? Because infrared light

New detectors are bringing us fresh, detailed views of nebulae and galaxies.



Ian Gatley, NOAO

waves have longer wavelengths than visible light, which enables them to pass through gas and dust in space that blocks visible light. And many molecules emit energy only in the infrared part of the spectrum.

To record the low energy of infrared waves, scientists make their detectors out of hybrid combinations of exotic chemicals such as tellurium, cadmium, indium, and antimony instead of the silicon found in CCD and video cameras, which is insensitive to infrared light. The new arrays are huge by old infrared detector standards: they have 256 by 256 elements.

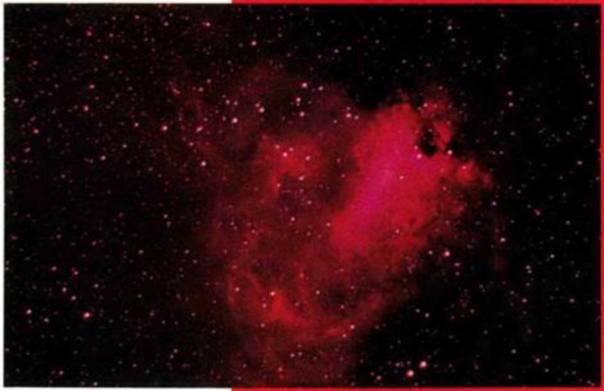
Actually, though, it's not the sensitivity and size of the arrays that make the new infrared detectors exciting to astronomers. What excites them is what they are seeing with the new arrays.

For example, consider the Omega Nebula (M17) in Sagittarius, which is familiar to many backyard astronomers. Visible light images (right) show that this is a place where massive stars are being born. The stars formed in a cool cloud containing molecular hydrogen gas. But the radiation from the young, hot stars heats up the leftover gas and makes it shine, producing the beautiful emission nebula we see.

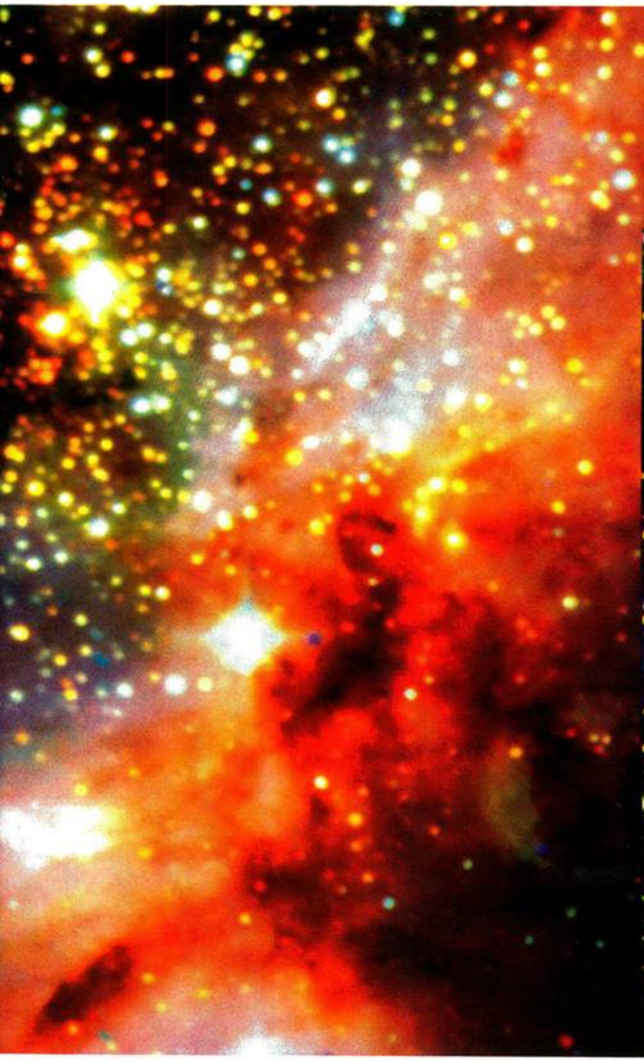
Yet this view is deceiving. The brightest part of the nebula doesn't appear in visible light photographs because dust in the densest part of the gas cloud hides it from view. Infrared radiation, however, penetrates the dust, making infrared images a perfect means to see rich stellar nursery in this part of the nebula.

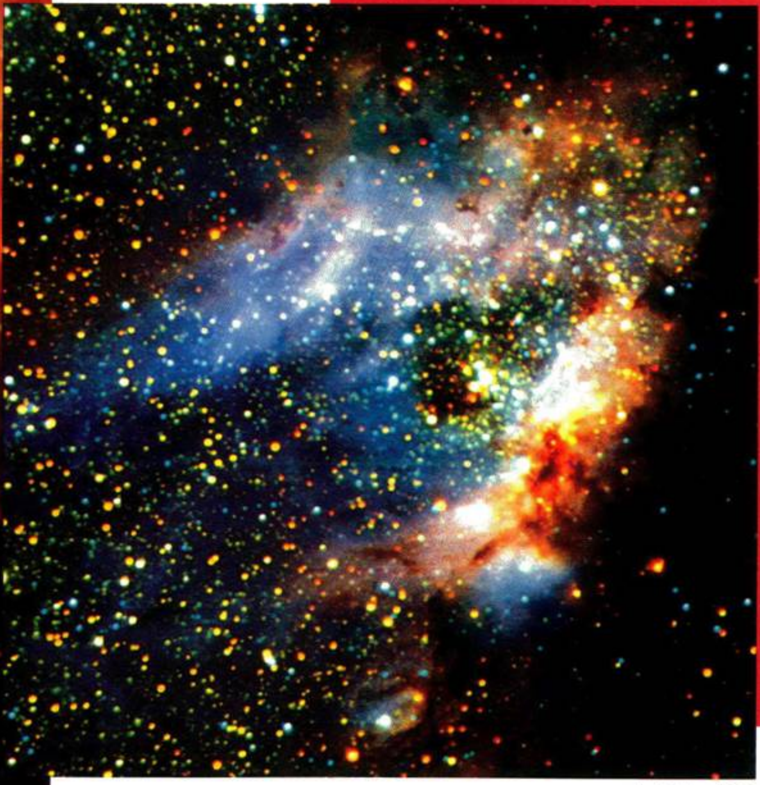
Of course our eyes can't see infrared. But to reap the information contained in infrared "color" images, we assign colors to different infrared wavelengths. In the

INFRARED CUTS THROUGH the gas and dust of M17 seen in visible light (below) to show the heart of the nebula (bottom). The close-up view below left better shows the star-producing factory in the nebula's center.



Michael Stecker





Ian Gatley, NOAO

pictures in this article, blue represents the light emitted at 1.2 microns, green that at 1.6 microns, and red that at 2.2 microns. These false-color images show us what our eyes would see if they could detect infrared light.

Besides penetrating dust, infrared imaging has another advantage for studying nebulae. Molecular hydrogen doesn't emit at all in the visible part of the spectrum, making infrared images important for studying the distribution of this gas through the nebula.

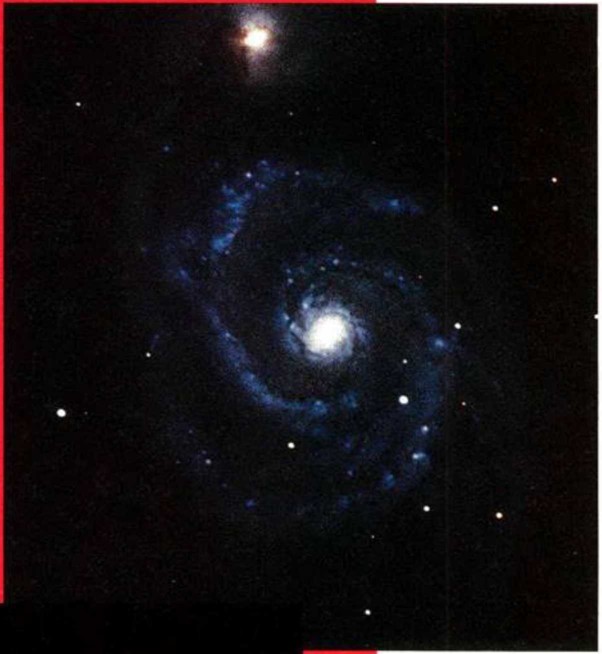
Because both atomic and molecular hydrogen gas emit at different wavelengths in the infrared, we can use infrared images to isolate different features of the gas cloud. Choosing the proper wavelengths allows us to view just the molecular hydrogen gas or just the atomic hydrogen gas. Subtracting another image made at a nearby wavelength removes all the stars so just the gas appears. This star-subtraction technique has revealed jets shooting from the molecular cloud located north of the Orion Nebula (M42).

Reversing the star-subtraction method takes away the gas and highlights the stars. The visible light and infrared images opposite reveal, as did the M17 images, many more stars in the infrared image. These stars lie buried in the molecular cloud — another star factory — behind the Orion Nebula.

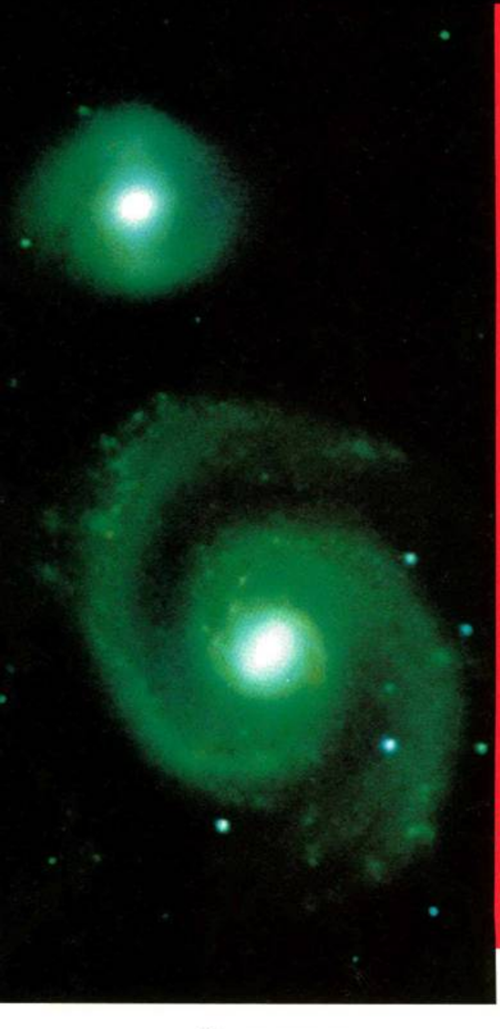
Other images show that the Orion Nebula emits bright emission lines of molecular hydrogen. These lines indicate that the wind blowing off the surface of a young star in the molecular cloud collides with gas in the nebula, heating it to about 2000 kelvins. Other emission lines suggest that ultraviolet radiation from young, hot stars is lighting up a wispy infrared halo around the Orion Nebula. Yet other observations reveal that ultraviolet radiation from young stars strips electrons from the hydrogen gas to ionize it. This ionized gas forms a cavity within the molecular cloud. So infrared observations reveal a wealth of features unseen in visible light. But more important, they show how the structure of the Orion Nebula is intimately tied to the cycle of star birth inside the gas cloud.

Another marvelous discovery came out of images of another famous object, the Ring Nebula (M57) in Lyra (opposite page). Previous low-sensitivity detectors couldn't see the faint, diffuse halo of filaments. The halo appears in some visible light images, but it appears prominently in recent infrared images. Astronomers had always interpreted this ring as

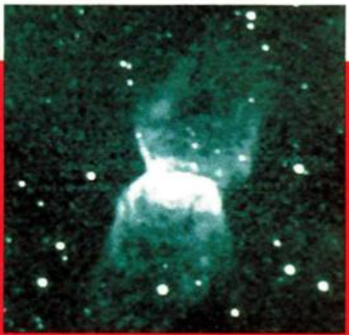
INFRARED IMAGES SHOW A BAR in the companion galaxy to the spiral galaxy M51 (bottom) that is unseen in this visible light image (below).



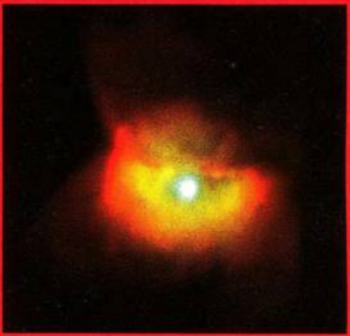
U. S. Naval Observatory



Ian Gatley, NOAO

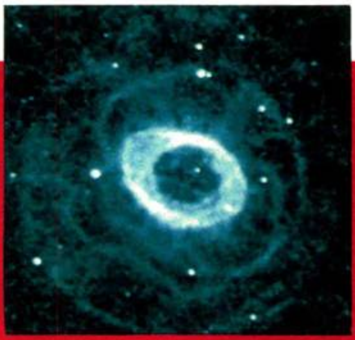


Ian Gatley, NOAO

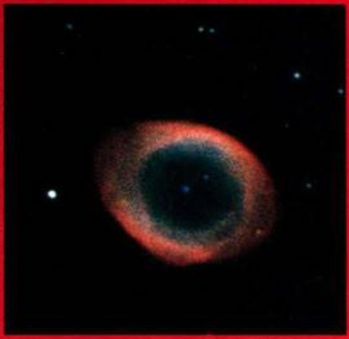


Bruce Balick, U. Washington/NOAO

THE PLANETARY NEBULA NGC 2346 looks like a disk with wispy wings in visible light images (right) but shows clearly an hourglass shape in the infrared (left). This indicates that the dying star at the center of the nebula didn't blow off a *spherical shell of gas* but rather ejected a doughnut-shaped shell. The star's wind interacts with this shell to form a cylinder of material, which seen at an angle forms the hourglass shape we see.



Ian Gatley, NOAO



Jack Marling

THE RING NEBULA (M57) SHOWS a shell of gas in visible light (right) and a complex halo in the infrared (left). The central star threw this gas off about 20,000 years ago during the final stages of its life. But instead of its being a spherical shell of gas, astronomers now think that this (and other planetary nebulae) is a cylinder of gas viewed from the top.

a spherical shell of gas ejected by the central star during its final death throes. At the nebula's center we look easily through the shell's thin gas. But at the edge we look along the shell and thus see the emission of much more gas.

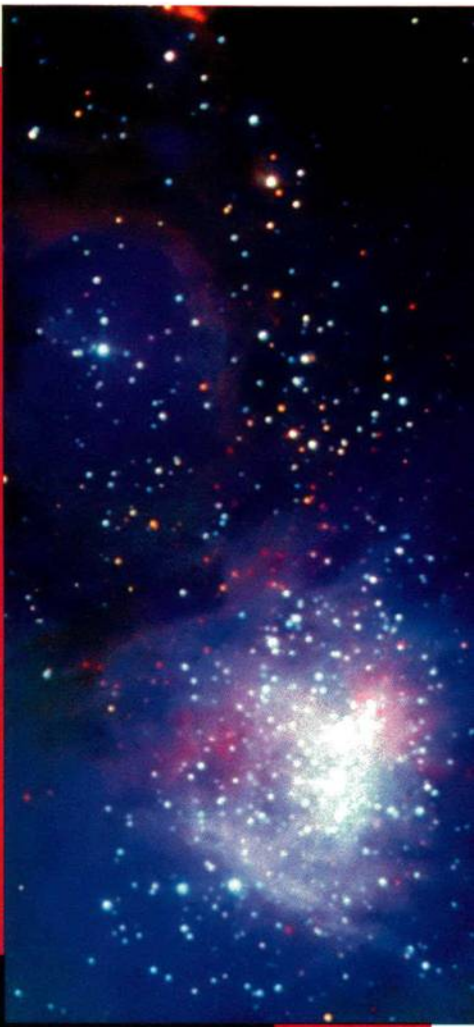
But the new images suggest something. Perhaps the structure isn't spherical after all. The ring could be a cylinder that we are peering down upon. Other planetary nebulae (so-named because they appear like the disk of a planet when observed through a small telescope) also suggest that these stellar eruptions occur as cylindrical or hourglass-shaped, not spherical, ejections of gas.

One example is NGC 2346 in the constellation Monoceros. We see this cylindrical planetary nebula nearly edge-on. If we could look down into this cylinder, we might see something like the Ring Nebula. From our side view, the inner ring appears as the bright part near the center, while the halo of filaments shows up as distinct X-shaped extensions of the nebula.

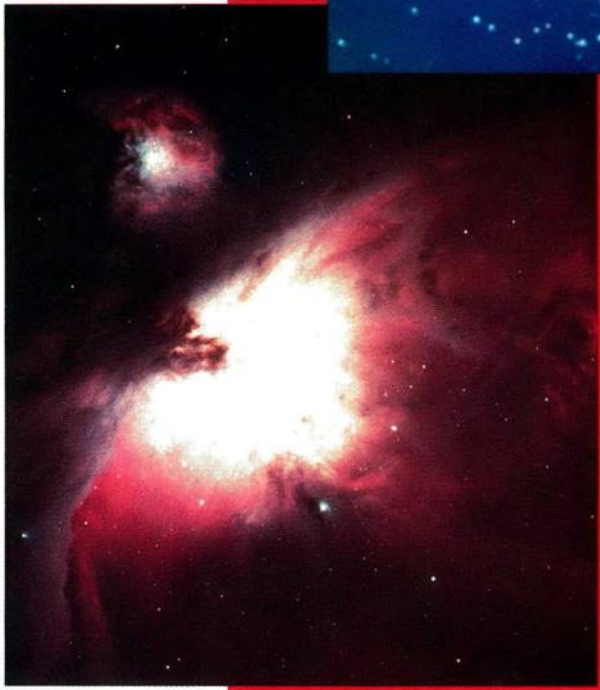
Because of its ability to penetrate gas and dust, infrared imaging also has provided new detailed views of galaxies. For example, visible light images of the companion to the spiral galaxy M51 in Canes Venatici have suggested the existence of a bar. But infrared images of the companion reveal the bar easily. This galaxy (NGC 5195) has collided with M51, disrupting its original shape. Perhaps the bar is a result of this collision.

These infrared images are just a few that are helping astronomers reshape their views of nebulae and galaxies. But that's not all. The next big breakthrough is imaging spectroscopy. The same device that holds the infrared camera at the telescope can also hold an infrared spectrometer. This instrument not only breaks the infrared light into its component wavelengths but does so at many different points of an object simultaneously. Think of it as taking an infrared image at many wavelengths all at once. Such an instrument lets researchers image of an object in the infrared and analyze the object's chemical make-up, motion, and temperature. This is a giant step forward in technology that will change infrared astronomers' ability to study celestial objects as dramatically as the rapid advance in detectors over the last decade has. □

Ian Gatley is an infrared astronomer at the National Optical Astronomy Observatories in Tucson, Arizona.



Ian Gatley, NOAO



Tony & Daphne Hallas

STAR FACTORY EXTRAORDINAIRE: the Great Orion Nebula (M42) shows a wealth of newly formed stars in the infrared (top) that the nebula's gas hides in visible light images (above).

HUBBLE Better than New

"Hubble is fixed beyond our wildest expectations," says Ed Weiler, space telescope project scientist.

by David Bruning

On December 18, astronomers gathered at the Space Telescope Science Institute in Baltimore, Maryland, to view the first images from the recently repaired space telescope. After 3½ years, the astronomers waited anxiously, wondering whether their optical prescription would fix the blurry vision. And then the image appeared.

"Absolutely incredible."

"Wow!"

"The first images sent shivers down our spines."

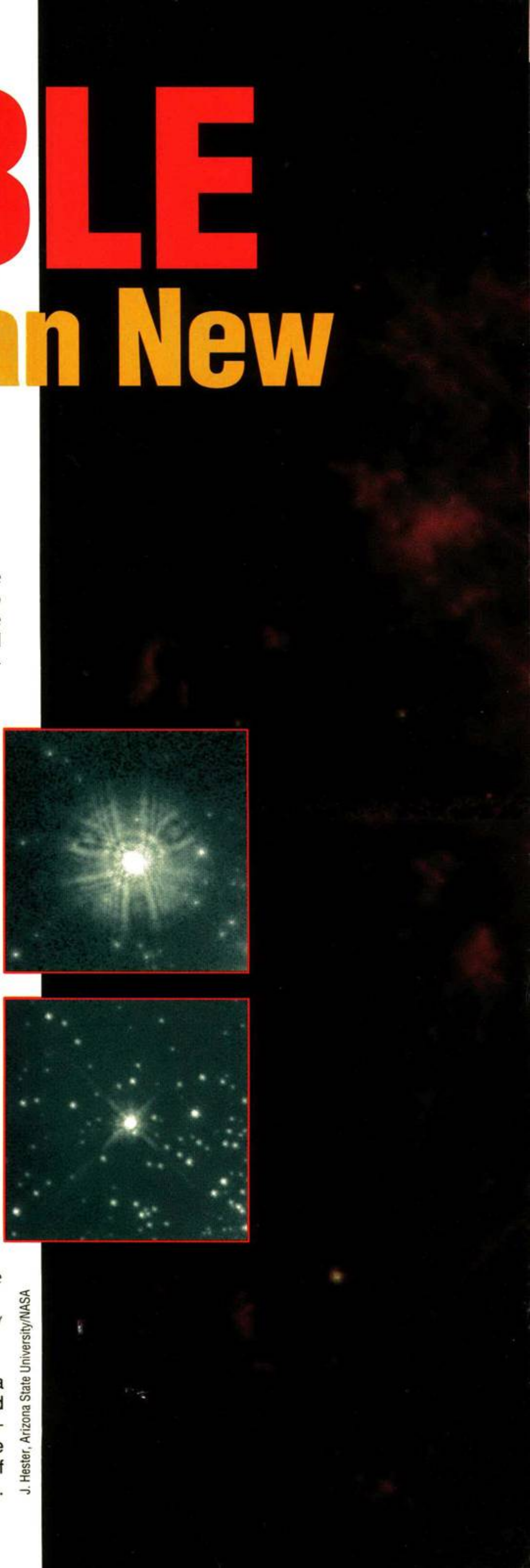
The verdict from astronomers is in: Hubble is fixed and better than anyone could have imagined.

Part of the added improvement comes from the use of 1990s' detectors in the new Wide Field and Planetary Camera (WF/PC II, pronounced "wif pik two") rather than the vintage-1970s' detectors in WF/PC I. The telescope also has better on-board processing power, better solar arrays, and better equipment for pointing. So Hubble doesn't just perform optically as well as it should have in 1990 when it was launched, it performs better. As Chris Burrows of the Space Telescope Science Institute says, "It's a small change for a mirror but a giant leap for astronomy."

Project scientists commend the astronauts for their careful repairs. When the first images arrived, scientists found that the astronauts hadn't bumped any of the instruments while installing them and left the optics in the replacement instruments undisturbed. Their careful handling shortened the time needed to focus the instruments.

Telescope operators needed to make only small adjustments in the focus. WF/PC II was within a fraction of a millimeter in focus and two percent of alignment — essentially dead-on, given the engineering tolerances for the latches that hold the instruments in the telescope.

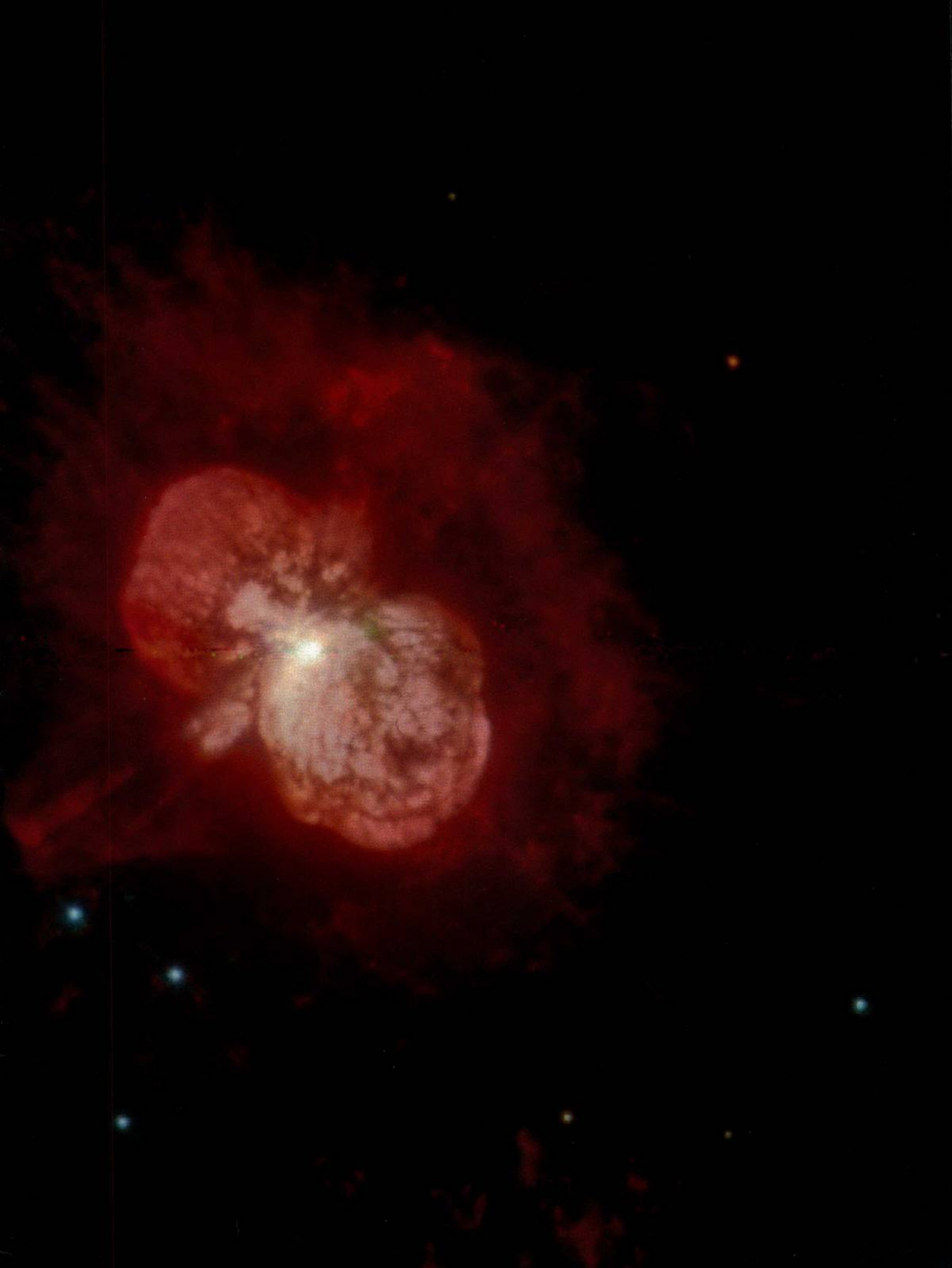
Looking at a star image reveals how well Hubble now

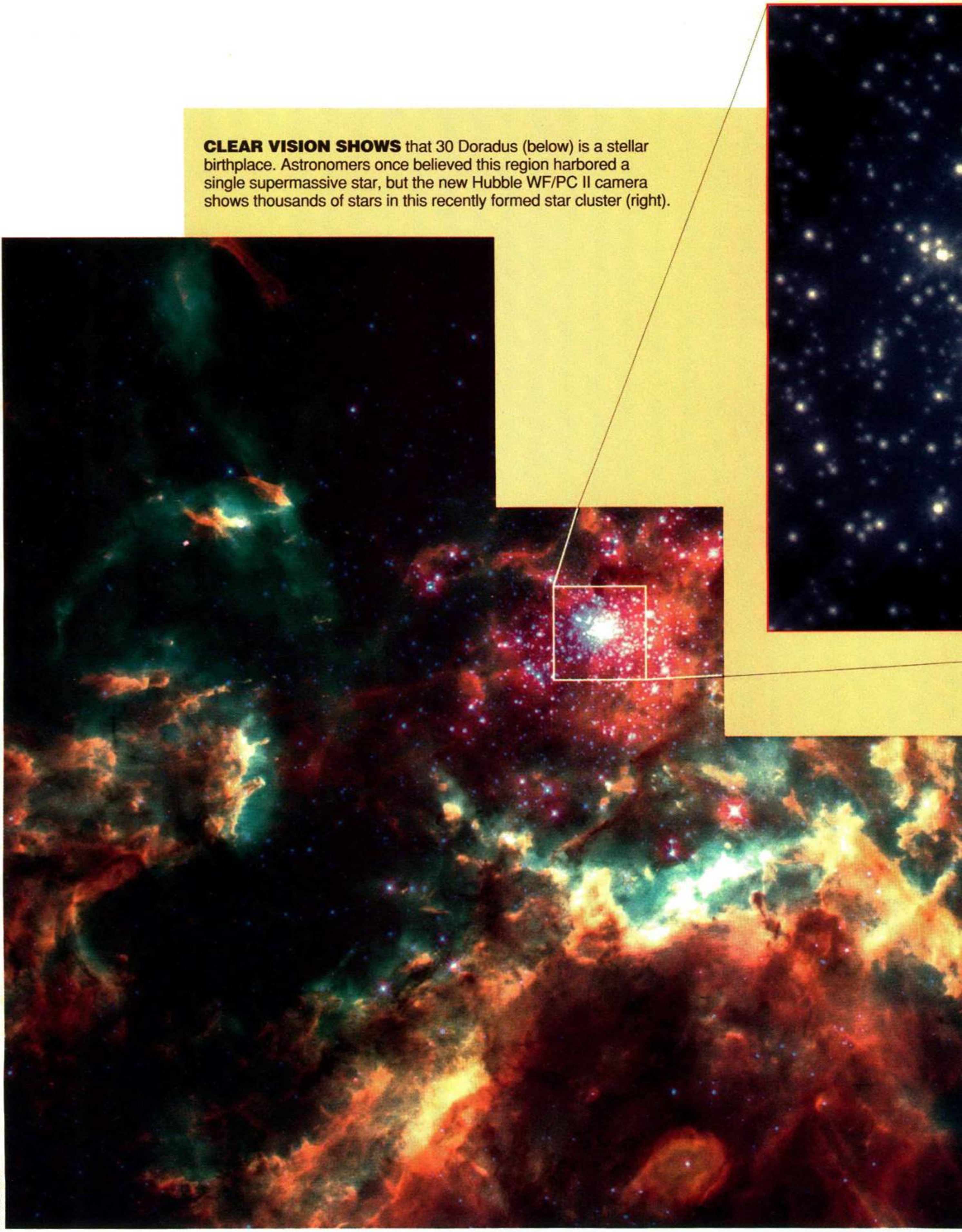


HUBBLE REVEALS STUNNING DETAIL in Eta Carinae (right), a massive star that has violently expelled gas from its outer layers. These details were hidden in earlier Hubble images because the flawed optics spread the object's light over a broad region (top inset) instead of focusing it crisply (bottom inset) as Hubble does now.

STScI/NASA

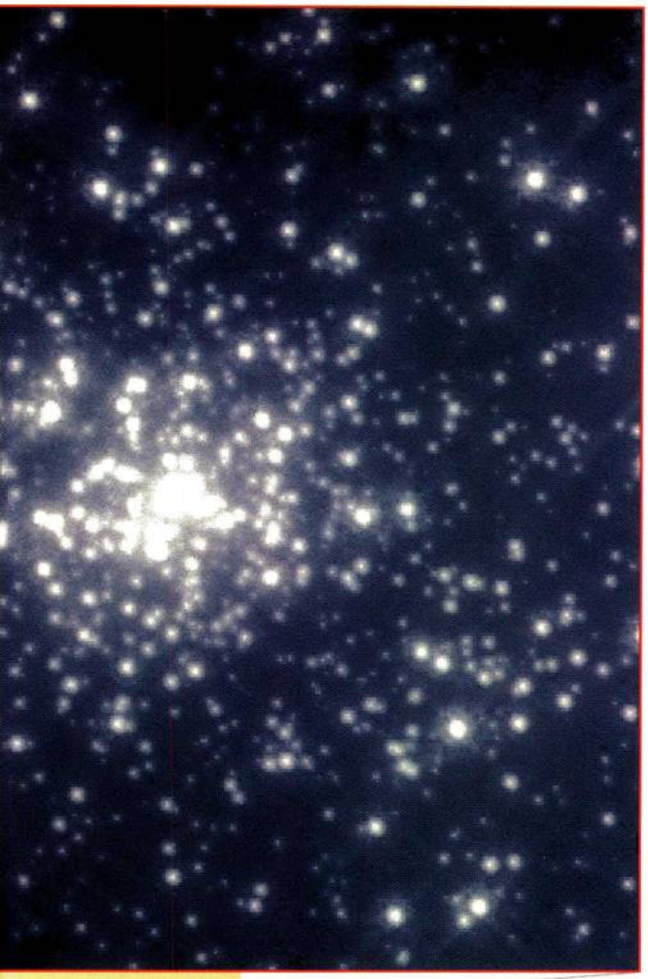
J. Hester, Arizona State University/NASA

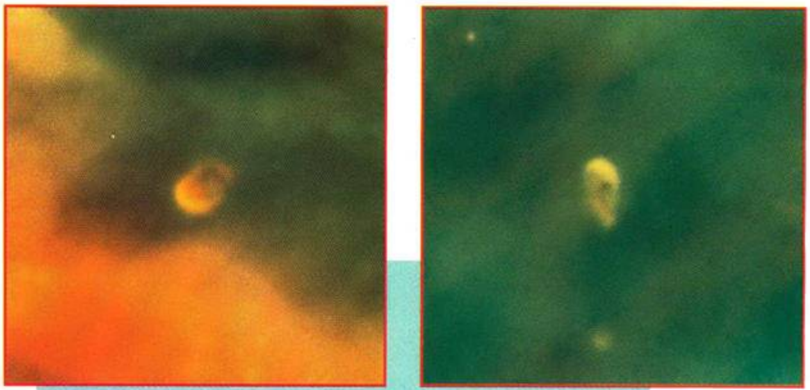




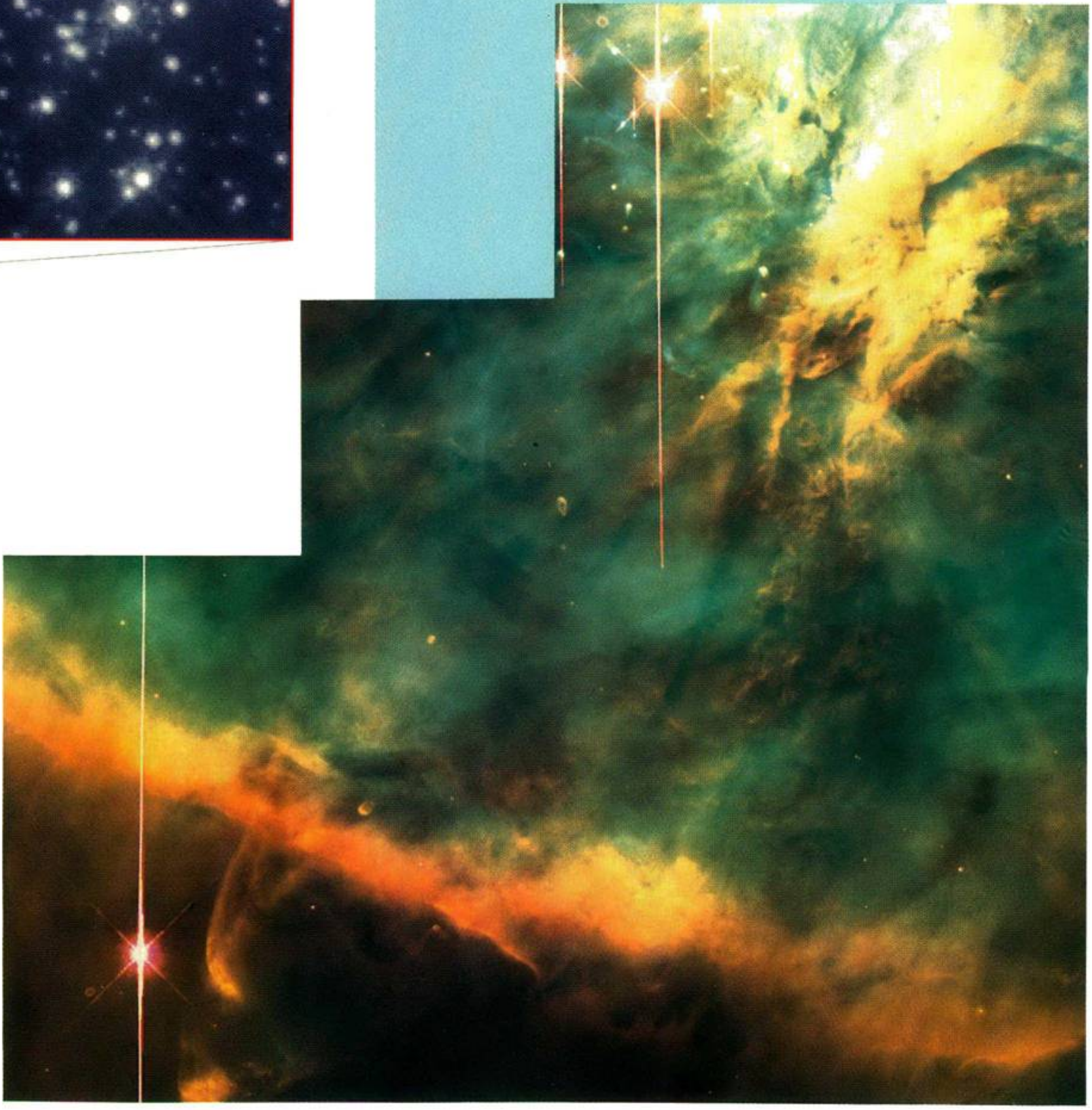
CLEAR VISION SHOWS that 30 Doradus (below) is a stellar birthplace. Astronomers once believed this region harbored a single supermassive star, but the new Hubble WF/PC II camera shows thousands of stars in this recently formed star cluster (right).

STScI/NASA

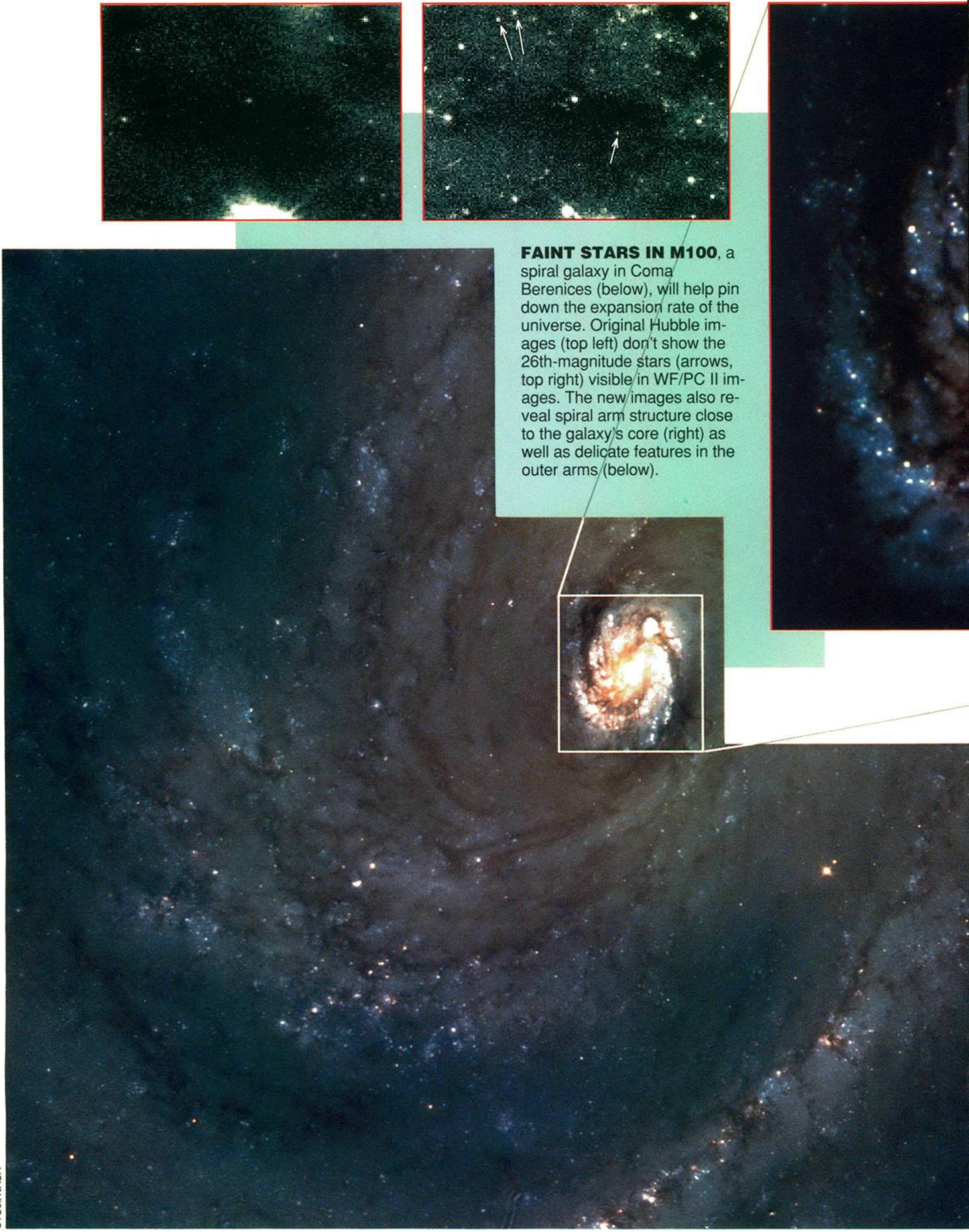




DISKS OF GAS AND DUST about the size of our planetary system surround several young stars that formed 300,00 years ago in the Great Orion Nebula (above). The entire image below is about 1.6 light-years across its diagonal length.



C.R. O'Dell, Rice University/NASA



FAINT STARS IN M100, a spiral galaxy in Coma Berenices (below), will help pin down the expansion rate of the universe. Original Hubble images (top left) don't show the 26th-magnitude stars (arrows, top right) visible in WF/PC II images. The new images also reveal spiral arm structure close to the galaxy's core (right) as well as delicate features in the outer arms (below).

STScI/NASA

performs. A perfect image of a star looks like a bright, tiny central disk surrounded by fainter rings of light. In this perfect image, 85 percent of the star's light lies in the central disk. Hubble originally focused only 12 percent into the central disk, spreading the rest into a huge region around the star. Astronomers hoped to get at least 60 percent into the central disk and dreamt of 70 percent. The first images from WF/PC II show that *over* 70 percent of the light lies in the central disk. Everything indicates that WF/PC II is functioning as close to theoretical limits as possible.

The improved optical performance means that we will see more detail in images. The telescope now has the resolution needed to separate two fireflies 10 feet apart in Tokyo as seen from Washington, D. C., and it's sensitive enough to detect individual flashes from the fireflies. Before the fix, image processing restored some detail in earlier Hubble images, but it also added spurious details. The new images don't require extra processing so everything seen in them is real. From the ground, telescopes can see with clarity to about 1 or 2 billion light-years. WF/PC I could see out to 3 or 4 billion light-years. But WF/PC II will see with clarity out to 10 or 12 billion light-years. Because it takes light 10 or 12 billion years to reach us from those distances, astronomers will be able to look back in time to see galaxies in stunning detail as they were first forming. Science observations with WF/PC II started at the end of January 1994.

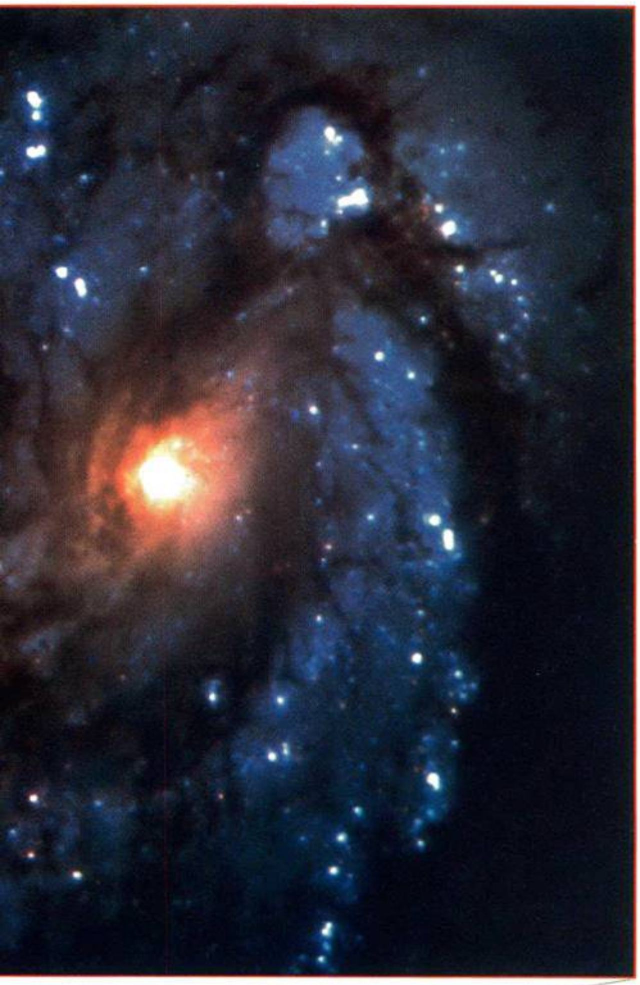
It was clear by late December 1993, just two weeks after the servicing mission, that no problems existed with WF/PC II. In fact, says John Trauger of the Jet Propulsion Laboratory in Pasadena, California, WF/PC II team leader, "The most surprising thing has been that there have been no surprises." So scientists deployed the first set of mirrors on COSTAR, the Corrective Optics Space Telescope Axial Replacement. Hubble's other three instruments — the Faint Object Camera, Faint Object Spectrograph, and Goddard High Resolution Spectrometer — use separate sets of mirrors on COSTAR to properly focus light from the flawed primary. The first set deployed focuses light for the Faint Object Camera. Astronomers found its focus within only a few tenths of a percent from ideal.

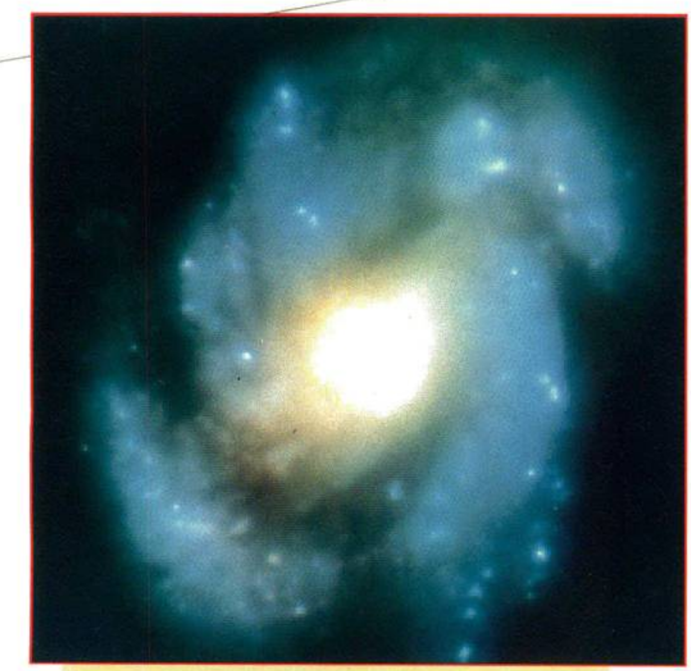
"We *nailed* it," says Jim Crocker of the Space Telescope Science Institute and COSTAR team leader.

The Faint Object Spectrometer had its mirrors on COSTAR deployed in early January and those for the Goddard High Resolution Spectrometer in late January. Because the image blurring has been fixed and the light concentrated in the central disk of the image, the instruments can see objects at least six times fainter than before.

Hubble scientists presented the images shown in this article to almost 2,000 astronomers at a meeting of the American Astronomical Society in January. Silence met the images when they were first displayed on the giant projection screen. The speechless researchers then burst into applause as image after image appeared on the screen. It was the clearest proof possible that Hubble is fixed and ready to do science.

By all standards, Hubble is now a success. Even with its flawed optics, it did important science and now it can tackle new programs. One program that astronomers are eager to start is the measurement of the expansion rate of the universe, the so-called Hubble constant. Perhaps by the end of this year they will be able to choose between the two contending values for the Hubble constant. And for some of us, that alone will make all of Hubble's troubles disappear for good. □





COMPARE THIS IMAGE from WF/PC I with its counterpart above from WF/PC II to see the dramatic increase in clarity afforded by the new camera. Details as small as 30 light-years across, such as intricate dust lanes, are visible now in this galaxy.

SKY ALMANAC

April 1994

Jupiter at Its Best

The giant planet Jupiter dominates the night sky in April, reaching opposition on the 30th when it lies opposite the Sun in our sky and remains visible all night. Jupiter then appears at its brightest for the year, shining at magnitude –2.5 and presenting a 45"-diameter disk.

Hunt the Young Moon

The evening of April 11 offers a great opportunity to spot a razor-thin crescent Moon. Observers with clear skies and an unobstructed horizon should see the one-day-old Moon hanging very low in the west about 20 to 30 minutes after the Sun sets.

The Moon Takes Aim at Venus

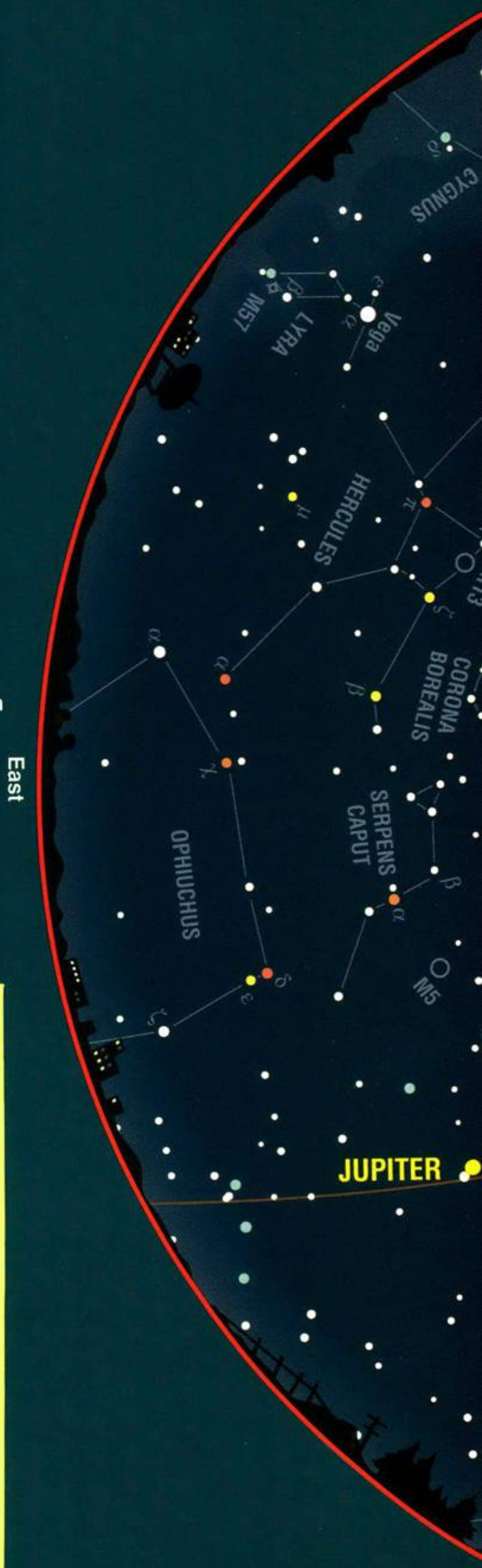
One night after the young Moon appears in the evening sky, the slightly thicker crescent Moon slides past Venus. While evening twilight still paints the western sky on April 12, people throughout North America can see the brilliant planet about 1° from the Moon.

Comet Tempel 1 Reaches Opposition

A periodic comet on its way back to the inner solar system puts on a good telescopic show this month. Comet Tempel 1 reaches opposition on April 4, when it shines at 10th magnitude. But stay tuned because the comet will brighten over the next few months.

A Pair of Asteroids

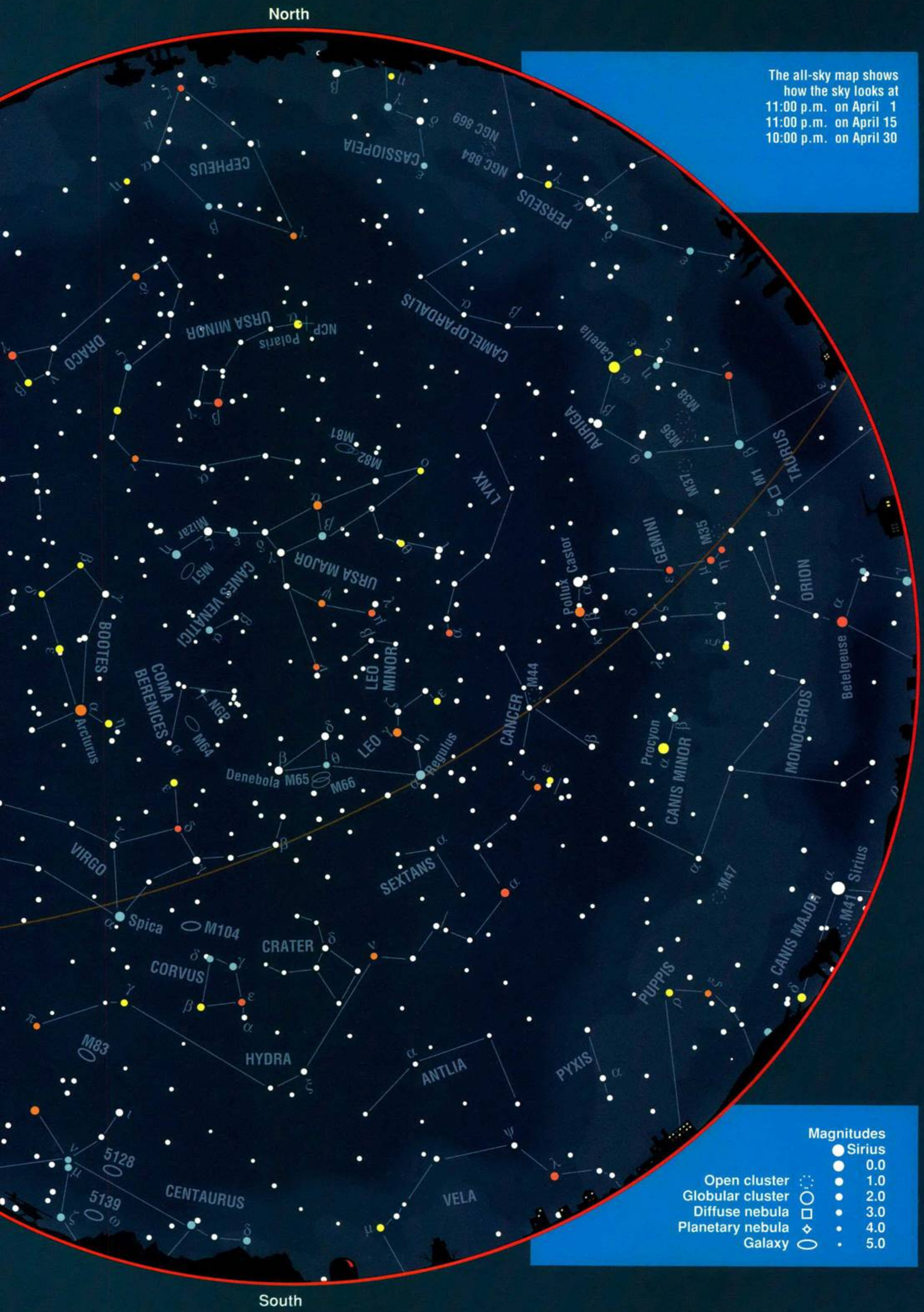
Asteroids 3 Juno and 10 Hygiea both reach opposition this month, when they appear at their brightest and can be seen throughout the night. The two telescopic objects glow between 9th and 10th magnitude among the background stars of Virgo.



CALENDAR OF EVENTS

2	Last Quarter Moon is at 9:55 p.m. EST
3	The Moon passes 4° north of Neptune, 6 p.m. EDT Mercury passes 1.5° south of Mars, 10 p.m. EDT The Moon passes 5° north of Uranus, midnight EDT
4	Comet Tempel 1 is at opposition Mars is at perihelion (128.4 million miles from the Sun)
6	Asteroid Hygiea is at opposition
7	The Moon passes 7° north of Saturn, noon EDT
8	The Moon passes 6° north of Mars, 10 p.m. EDT
9	The Moon passes 7° north of Mercury, 7 a.m. EDT
10	New Moon is at 8:17 p.m. EDT
11	The Moon is at apogee (252,568 miles from Earth), 7:50 p.m. EDT
12	The Moon passes 1.0° north of Venus, 7 p.m. EDT
14	Asteroid Juno is at opposition
18	First Quarter Moon is at 10:34 p.m. EDT
22	Lyrid meteor shower peaks
24	The Moon passes 0.6° south of Spica, 10 p.m. EDT
25	The Moon is at perigee (221,785 miles from Earth), 1:18 p.m. EDT Full Moon is at 3:45 p.m. EDT
26	The Moon passes 3° south of Jupiter, 1 a.m. EDT
28	Asteroid Vesta is in conjunction with the Sun
30	Jupiter is at opposition Mercury is in superior conjunction

The all-sky map shows
how the sky looks at
11:00 p.m. on April 1
11:00 p.m. on April 15
10:00 p.m. on April 30


North
CEPHEUS
CASSIOPEIA
NGC 869
NGC 884
PERSEUS
DRACO
URSA MINOR
Polaris
NCP
CAMELOPARDALIS
Capella
AURIGA
M38
M36
M37
M1
TAURUS
M81
M82
LYNX
Mizar
M51
CANES VENATICI
URSA MAJOR
GEMINI
M35
Castor
Pollux
ORION
Betelgeuse
West
BOOTES
Arcturus
COMA BERENICES
NGP
M64
LEO MINOR
LEO
Regulus
Denebola
M65
M66
CANCER
M44
Procyon
CANIS MINOR
MONOCEROS
VIRGO
Spica
M104
SEXTANS
CRATER
CORVUS
M47
Sirius
M41
CANIS MAJOR
PUPPIS
M83
HYDRA
ANTLIA
PYXIS
5128
5139
CENTAURUS
VELA
South
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0
Open cluster
Globular cluster
Diffuse nebula
Planetary nebula
Galaxy

SKY ALMANAC

by Deborah Byrd and Rick Shaffer

On spring evenings, the ecliptic — the path of the Sun, Moon, and planets across the sky — makes a steep angle to the western horizon. That makes this time of year ideal for searching for objects just slightly east of the Sun in the sky. After the Sun sets on April 11, try scanning in the west for the very young Moon. The Moon is about a day old that evening; in other words, it's about a day past the time when it passed most nearly between us and the Sun for this month.

Such a young Moon appears as a hairline crescent low in the evening twilight sky. It is a lovely sight for those who have an unobstructed view to the west. Be sure to look no later than about half an hour after sunset, after which the Moon sinks too close to the horizon.

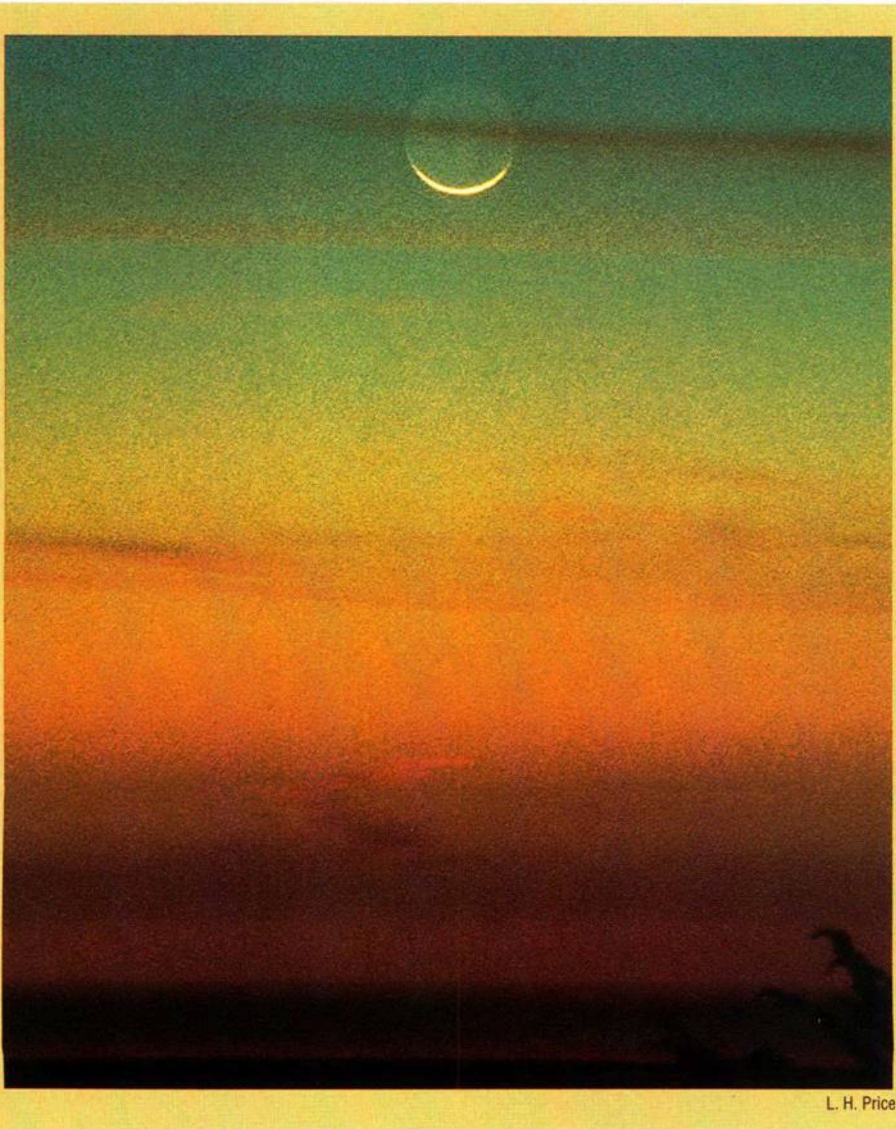
The very bright object above the young Moon is Venus, the next world inward from Earth in orbit around the Sun. On April 11, Venus lies about 10° to the upper left of the young Moon, but it can be found in the west any evening this month. On April 12, the Moon passes extremely close to Venus. The Moon actually travels in front of Venus as seen from the Arctic.

On April 1, the largest planet in our solar system, Jupiter, rises in the east-southeast about two-and-a-half hours after sunset. It rises earlier each night as the month passes, finally rising as the Sun sets on the night of April 29/30. That is the night of opposition, when Jupiter appears opposite the Sun in our sky and remains visible all night long.

Opposition marks the closest approach of Earth to Jupiter during the year, so the giant planet then appears largest and reflects the most sunlight back in our direction. As a result, it imperceptibly brightens during the course of April, from magnitude –2.4 on the 1st to its maximum for the year, magnitude –2.5, on the 29/30th.

Be sure to turn your telescope on Jupiter this month. Small telescopes reveal its cream-and-tan cloud bands and its four largest moons. This planet always appears large when viewed telescopically, but it swells to its maximum apparent size for the year at opposition in late April, when its disk measures 45" across.

When you have finished gazing at Jupiter, move your telescope toward the constel-



L. H. Price

Search for a Young Spring Moon

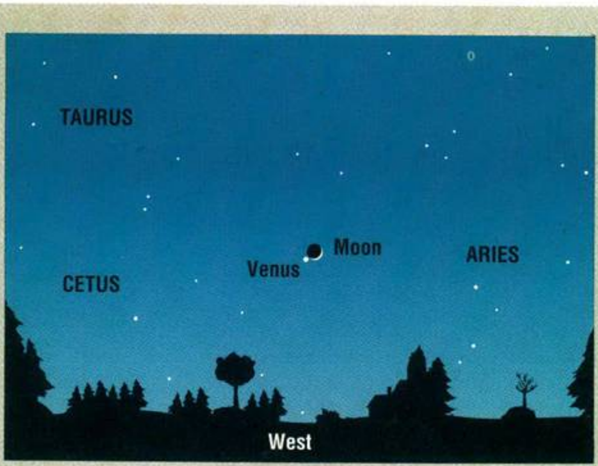
It's not often that you can see the Moon just a day after it's new, when it passes directly between the Sun and Earth. But this month you can, thanks to the steep angle of the ecliptic to the western horizon on spring evenings. The Moon is new at 8:17 p.m. EDT on April 10 and should be visible as a ghostly crescent shortly after sunset the following evening.

Thirty minutes after sunset on the 11th, the Moon stands about 5° above the point where the Sun went down. You can use Venus as a reference: The bright planet lies 13° high at that time and about 5° to the left of the Moon. Use binoculars to sweep near the horizon if you have to, but then put them aside and try to glimpse the crescent with your naked eye.

lation Hercules to glimpse one of our Galaxy's oldest inhabitants. Most backyard observers consider the great globular cluster M13 in Hercules to be the best such star cluster visible from the Northern Hemisphere. You can spot this object with your naked eye or binoculars, but a telescope begins to resolve the outer part of the cluster into thousands of pinpoint stars.

M13 is one of the spring sky's permanent features. But this month you can also see a temporary visitor to our night sky. Comet Tempel 1 reaches opposition on April 4 and brightens to 10th magnitude later in the month. When you aim your telescope toward it, contemplate the great elliptical journey it takes around the Sun.

Two other solar system members reach opposition this month and so are well placed for evening viewing.


TAURUS
CETUS
Venus
Moon
ARIES
West

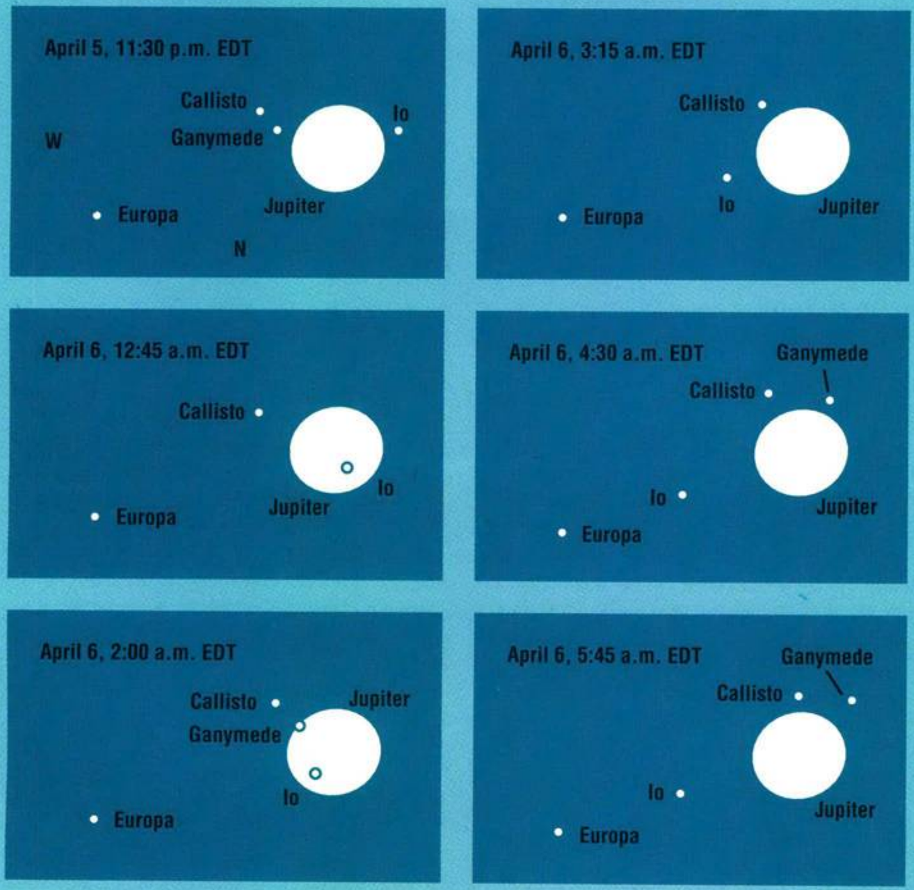
The Moon Joins Venus

The evening after the Moon first reappears in the evening sky (left), it skims past the bright planet Venus. Closest approach comes at 7 p.m. EDT on April 12, so the timing is perfect for observers in eastern North America. But even from farther west, the two objects make a stunning sight.

This event should make for a great photo opportunity. Because both objects are relatively bright, you can take a picture of the two with just a tripod-mounted camera. Try placing local landmarks in the foreground for visual interest, and if you have them use lenses of different focal lengths to see which gives the most pleasing image.

If you happen to live in northern Greenland or northeast Asia, the Moon actually occults Venus, meaning the Moon passes in front of Venus and blocks the planet's light from view. The occultation will be difficult to observe, however, because in most of those regions it occurs during daylight.

The Dance of Jupiter's Satellites — April 5/6


April 5, 11:30 p.m. EDT
Callisto
Io
W
Ganymede
Europa
Jupiter
N
April 6, 3:15 a.m. EDT
Callisto
Europa
Io
Jupiter
April 6, 12:45 a.m. EDT
Callisto
Io
Europa
Jupiter
April 6, 4:30 a.m. EDT
Ganymede
Callisto
Io
Jupiter
Europa
April 6, 2:00 a.m. EDT
Callisto
Jupiter
Ganymede
Io
Europa
April 6, 5:45 a.m. EDT
Ganymede
Callisto
Io
Jupiter
Europa

Jupiter reaches opposition on the night of April 29/30, when it will be visible throughout the night. Because the riot of dark belts and bright zones on Jupiter is so rewarding to view, we've devoted a whole article on how to observe it (see "Jupiter's Magnificent Show" on page 74).

But Jupiter has more to show. On the night of April 5/6, observers in North America can watch Jupiter's brightest moon, Ganymede, pass into Jupiter's shadow and then get occulted by the disk of the planet. The action starts at 11:47 p.m. EDT, when Ganymede winks out as it passes into the giant planet's shadow.

For the next 2 hours and 9 minutes it is gone from view, reappearing just off the western limb of the planet at 1:56 a.m. Twenty-two minutes later it's gone again, passing behind the planet, only to return for good at 3:53 a.m. Ganymede's smaller cousin, Io, also gets in on the action that night. It passes in front of Jupiter from 12:13 a.m. to 2:21 a.m., while its shadow races across Jupiter's cloudtops from 11:39 p.m. to 1:49 a.m.

Asteroids 3 Juno and 10 Hygiea reside in Virgo, where you can find them with binoculars or a telescope. Juno shines at magnitude 9.8 at opposition on April 14/15, about half a magnitude dimmer than Hygiea when it reaches opposition on April 6.

If you are up before the Sun, look low in the east-southeast for the planet Saturn. Two planets lie below it in the predawn sky, but they are extremely difficult to see. Mercury most likely will remain too close to the Sun's glare for you to see it. But Mars is ascending in the predawn sky this month. You may glimpse it shortly before the Sun comes up, to the lower left of Saturn. On the mornings of April 7 and 8, the waning crescent Moon passes near these two planets.

April's Planets

Venus shines brightly in the west after sunset this month. At magnitude –3.9, it outshines all the other planets and stars. This is a good month to watch Venus climb higher into the western twilight sky with each evening.

This upward climb of Venus is mirrored in the downward shift of the brilliant "winter" stars. Every year at this time, these bright stars sink into the sunset glare, and this year Venus — a brilliant beacon in the twilight — serves as a prominent marker to track this group's descent in the western sky.

During the last week of April, you can watch Venus pass between two prominent star clusters, the Pleiades and Hyades in the constellation Taurus the Bull. The Pleiades has the shape of a tiny dipper, while the Hyades looks like the letter V. The brightest star in the direction of the Hyades is Aldebaran, a foreground star only about half as far away as the cluster. The Hyades represents the Bull's face, and Aldebaran the Bull's fiery red eye. The Pleiades represents the Bull's shoulder.

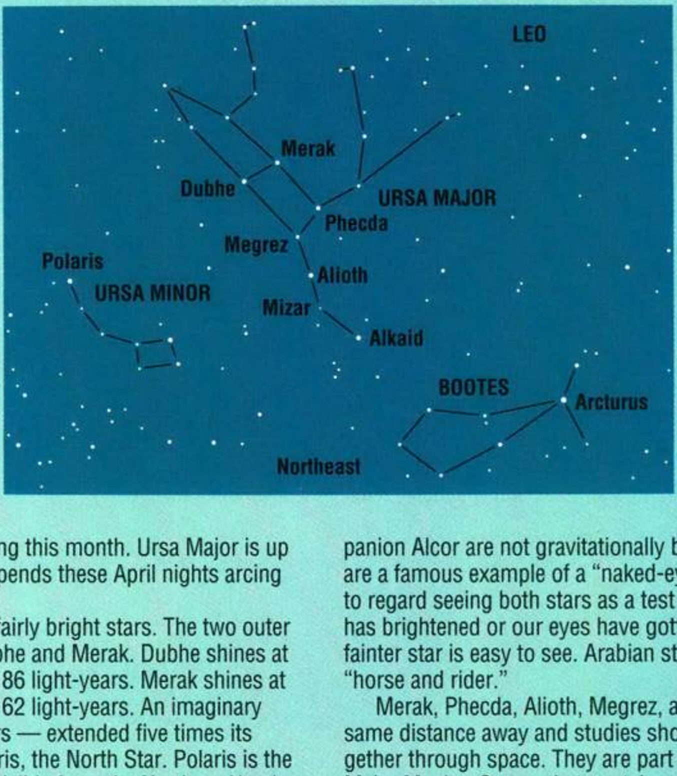
This month's second-brightest planet, **Jupiter**, rises about two-and-a-half hours after sunset on April 1. By the night of April 29/30, the planet has reached opposition and rises when the Sun sets.

Jupiter lies in western Libra throughout April. The bright star near the planet is Zubenelgenubi, also known as Alpha Librae. Because Jupiter is opposite the Sun at the end of April, you'll see it near another object also opposite the Sun, this month's Full Moon. The Full Moon lies near Jupiter throughout the night on April 25/26.

Pluto resides in Libra this month too and rises not long after Jupiter. At magnitude 13.7, Pluto is about a thousand times too faint to see

THE STARRY SKY

by Deborah Byrd



Relatively few people can identify more than a handful of objects in the night sky. But nearly everyone can identify one star pattern, the Big Dipper.

The Big Dipper is not a constellation. It's an asterism, or distinctive pattern of stars, within the constellation Ursa Major the Great Bear. This constellation and its famous asterism are well placed for viewing this month. Ursa Major is up in the east by early evening and spends these April nights arcing across the northern sky.

The Dipper consists of seven fairly bright stars. The two outer stars in the Dipper's bowl are Dubhe and Merak. Dubhe shines at magnitude 1.8 from a distance of 86 light-years. Merak shines at magnitude 2.4 from a distance of 62 light-years. An imaginary line drawn through these two stars — extended five times its own length — brings you to Polaris, the North Star. Polaris is the star around which the entire sky visible from the Northern Hemisphere appears to turn. For this reason, Dubhe and Merak are often called the Pointers.

The other bottom star in the bowl of the Dipper is called Phecda. It shines at magnitude 2.4 from a distance of 75 light-years. North of Phecda — at the place where the bowl joins the handle of the Dipper — is Megrez. It is the faintest of the Dipper's stars at magnitude 3.3, and lies 62 light-years away.

There are three stars in the Dipper's handle. Next outward from the bowl is Alioth, the brightest star in the Dipper at magnitude 1.8. Alioth is located 62 light-years away. At the end of the handle is Alkaid, the most distant of the Dipper's stars at 165 light-years. This star shines at magnitude 1.9.

That leaves one last star in the Big Dipper, the middle star in the handle. This star shines at magnitude 2.1 from a distance of 74 light-years. Look carefully, and you'll see another little star right next to it. Mizar and its companion Alcor are not gravitationally bound to each other, but they are a famous example of a "naked-eye double star." People used to regard seeing both stars as a test of eyesight, but either Alcor has brightened or our eyes have gotten stronger, because the fainter star is easy to see. Arabian stargazers called this pair the "horse and rider."

Merak, Phecda, Alioth, Megrez, and Mizar all lie about the same distance away and studies show them to be moving together through space. They are part of a star cluster, the Ursa Major Moving Group, that contains about 20 stars. This is the nearest known star cluster to our Sun.

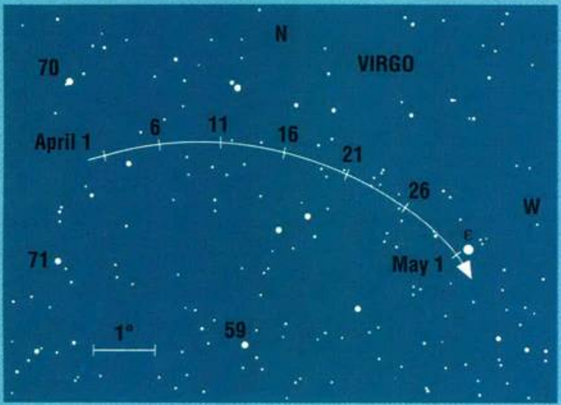
The Big Dipper can be used to identify other stars and constellations, in addition to the North Star. If you follow a curved line out from the Dipper's handle, you will come to the orange star Arcturus; in other words, "follow the arc to Arcturus." Extend this line southward to blue-white Spica; "drive a spike to Spica." Also, look for the constellation Leo, the bright star pattern directly south of the Dipper's bowl. (Next month: Legends About Ursa Major.)

Return of a Telescopic Comet

April marks the return of the second of three reasonably bright periodic comets to grace our skies in 1994. Comet Tempel 1 brightens to 10th magnitude during the course of April, putting it within range of binoculars or a small telescope. It reaches opposition on April 4, which places it in the sky all night long and high in the south around midnight.

You can find Tempel 1 this month in extreme northern Virgo, about 15° west-southwest of 0-magnitude Arcturus in Bootes or 13° due north of 1st-magnitude Spica in Virgo. But the nearest bright star to Tempel 1 is 3rd-magnitude Vindemiatrix (Epsilon [ε] Virginis). The comet lies just over 5° east of this star at the beginning of April and then closes to within 1° in late April. Positions in the finder chart and table are given for 11 p.m. EDT (10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT).

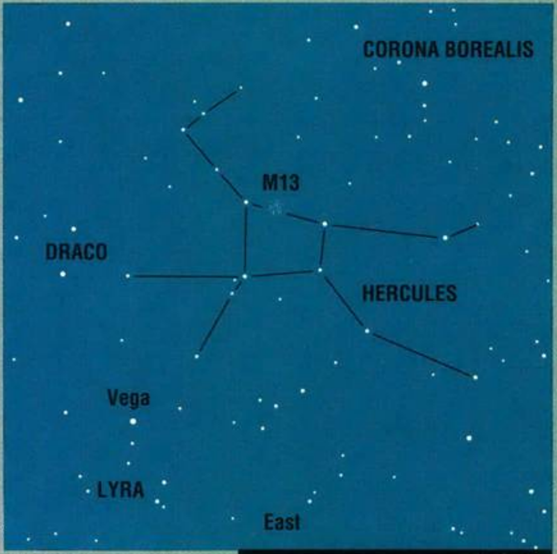
Fortunately, this part of Virgo is relatively barren, lying far enough east of the Virgo cluster of galaxies so you won't have to worry about confusing a galaxy for the comet. Tempel 1 should appear as a fuzzy ball of light that brightens by a magnitude during the course of April, from magnitude 10.6 to 9.6. It likely won't show a tail, because it remains 150 million miles from the Sun — far enough that not much of a tail would form — and any tail that does form will point away from us because the comet is near opposition.



COORDINATES FOR COMET TEMPEL 1

Date	R.A. (2000)	Dec.
Apr. 1	13h26.1m	12°34'
Apr. 6	13h22.5m	12°44'
Apr. 11	13h18.4m	12°45'
Apr. 16	13h14.1m	12°36'
Apr. 21	13h09.9m	12°15'
Apr. 26	13h06.0m	11°41'
May 1	13h02.6m	10°55'

The Great Hercules Globular



Joe Liddell

If you've only recently begun exploring the sky, these spring nights offer a great opportunity to view a new type of object. If you look toward the east during the late evening hours, you can pick out the constellation Hercules. Along the western edge of the Keystone asterism that makes up Hercules' body, you'll see a small patch of nebulous light. This is M13, the finest globular cluster visible in the northern sky. The cluster is a tightly packed spherical collection of some one million stars.

Although this cluster can be seen with the naked eye and must have been noticed by ancient observers, Edmond Halley of comet fame gets the credit for discovering it. M13 glows softly at magnitude 5.9 from a distance of about 25,000 light-years.

Since M13 is big and bright for a globular cluster, even binoculars or a small scope will give you a nice view. A 2.4-inch refractor will resolve a few of the stars around the cluster's periphery, while a 4-inch begins to resolve the rest. A 6-inch scope usually resolves stars clear across the cluster.

Many observers who view M13 in a small telescope report seeing several dark lanes that seem to meet near the center of the cluster, making it appear Y-shaped. This feature isn't real but rather an artifact of incompletely resolving the cluster with a small telescope. As you look at M13 in larger and larger telescopes, the feature becomes less and less apparent.

Globular clusters are one class of object that really improve if you see them in a large telescope. That's because as the aperture of the telescope goes up, the size of the star images it produces goes down. So not only does the large aperture intercept more of the cluster's light, it crams it into a smaller image than a small aperture does. That's why if you get the chance to go to a star party, be sure to view M13 in a big telescope — even if you have to stand in a long line. The wait will be worth it.

with the naked eye. You'll need an 8-inch scope to spot this dim planet. Next month Pluto reaches opposition, when it will be in the sky all night.

Uranus and **Neptune** both reside in the southeast before dawn, about 3° from each other in the star-rich constellation Sagittarius. Uranus shines at magnitude 5.7 and Neptune at magnitude 7.9. Both are a little brighter than last month, because Earth, as it travels around the Sun, is catching up to them in its smaller, faster orbit. We will pass between these planets and the Sun in July.

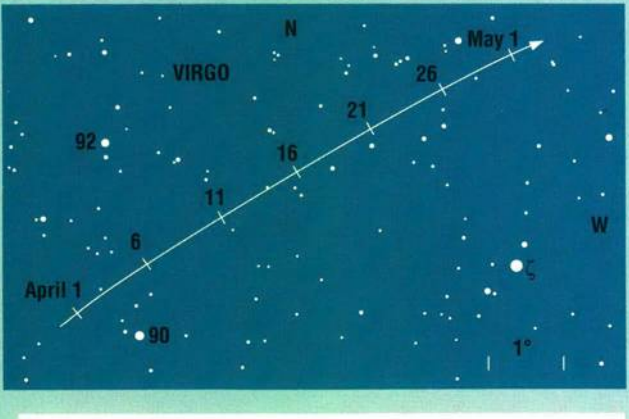
Saturn lies low in the east-southeast shortly before dawn, a relatively inconspicuous dot of light shining at magnitude 1.1. You can find it among the background stars of the constellation Aquarius the Water Bearer. If you have a very clear eastern horizon, you might glimpse Saturn early in the month about 45 minutes before the Sun comes up. Try looking on the morning of April 7, when the planet is the brightest object near the Moon.

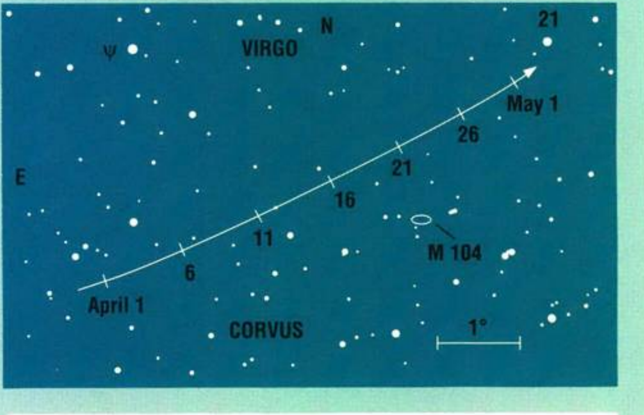
The ringed planet rises earlier each day as the month passes, coming up around 3 a.m. by late April. Saturn is just below a distinctive pattern of stars, an asterism, in Aquarius. The asterism, the Water Jar, consists of several 3rd-, 4th-, and 5th-magnitude stars in the shape of the letter Y. From the city or the suburbs, you should try sweeping for the Water Jar with binoculars.

Mars is officially up before dawn too, but it is below Saturn in the eastern sky and even more difficult to see early in the month. But like Saturn, it ascends in the east as the month passes, becoming visible below the ringed planet.

Mars shines at magnitude 1.2 against the backdrop of the constellation Pisces the Fish. Try looking for it on the

Two Asteroids in Virgo





COORDINATES FOR JUNO

Date	R.A. (2000)	Dec.
Apr. 1	13h58.0m	–1°13'
Apr. 6	13h54.3m	–0°34'
Apr. 11	13h50.4m	0°04'
Apr. 16	13h46.4m	0°40'
Apr. 21	13h42.5m	1°14'
Apr. 26	13h38.6m	1°44'
May 1	13h35.0m	2°11'

COORDINATES FOR HYGIEA

Date	R.A. (2000)	Dec.
Apr. 1	12h55.7m	–12°22'
Apr. 6	12h51.9m	–11°59'
Apr. 11	12h48.1m	–11°35'
Apr. 16	12h44.5m	–11°10'
Apr. 21	12h41.1m	–10°44'
Apr. 26	12h38.0m	–10°20'
May 1	12h35.4m	– 9°57'

April provides two telescopic asteroids for you to chase down. The first is one of the Big Four — the group of four large and bright asteroids discovered within a few years of each other in the early 19th century. The third of these chunks of rock to be discovered was 3 Juno, which reaches opposition this year on the night of April 14/15, when it rises at sunset and remains visible all night.

This month the 250-kilometer-diameter piece of debris left over from the birth of the solar system traverses central Virgo. At opposition Juno lies just over 3° northeast of the 3rd-magnitude star Zeta (ζ) Virginis. Juno itself glows quite faintly, at magnitude 9.8, but is easy to spot with a small telescope.

The other asteroid to reach opposition this month is 10 Hygiea, which joins Juno and Comet Tempel 1 in the constellation Virgo. Hygiea lies about 20° southwest of Juno, right near the border of Virgo and Corvus. It glows slightly brighter than Juno, at magnitude 9.2, when it reaches opposition on April 6.

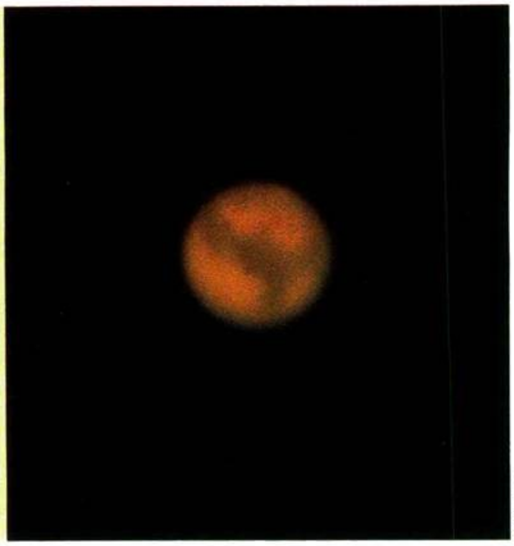
You should be able to spot Juno and Hygiea with the help of the finder charts and table of coordinates above, which both show the objects' positions at 11 p.m. EDT (10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT). If you have trouble picking either of them out from the background stars, center your telescope where the object should be and sketch or photograph the field of view. Then observe the same field a night or two later and look for the "star" that has changed position. That is the asteroid.

mornings of April 8 and 9, when it is near the waning crescent Moon. Mars is now far across the solar system from Earth, which is why it remains low in the twilight sky and appears inconspicuous. Although the Red Planet reappears this month before dawn, it's destined to remain low in the morning sky for some months to come. ☐

Deborah Byrd writes and produces the daily "Earth and Sky" radio series. Rick Shaffer is an engineer and writer living in Southern California.

Mars in the Morning Sky

The Red Planet has been lost in the Sun's glare for most of the past five months. But now Mars is coming up about an hour before the Sun and can be spotted low in the east during morning twilight. It's a 1.2-magnitude reddish "star" located just southeast of the Circlet asterism in Pisces at midmonth. Pay particular attention on the mornings of April 4 to 6, when Mercury passes just over a degree from Mars. You can view the pair about 30 minutes before sunrise from a location with an unobstructed eastern horizon.



D. W. Lyon

Keeping Tabs on Shoemaker-Levy 9

We are now only three months away from one of the big events of the year: July's collision of Comet Shoemaker-Levy 9 with Jupiter. When the comet passed close to Jupiter in 1992, tidal stresses broke Shoemaker-Levy 9 into, at last count, 21 separate comets. Now those pieces are all moving together toward oblivion.

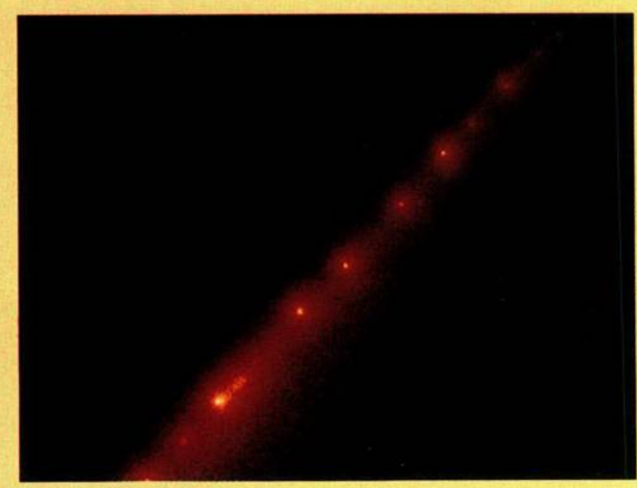
Although the effects of the comet's impact with Jupiter should be apparent to backyard observers this July, spotting the comet on the way to its demise will be very difficult. Some of the fun is in trying, however, so here are some tips for maximizing your chances. To spot the comet, you'll want a 12-inch or larger telescope with scrupulously clean optics, a dark observing site that provides steady seeing, and clear weather. Photographing the field conventionally or with a CCD camera will increase your odds of spotting it.

The table below gives you the position of the comet relative to Jupiter's position throughout April. To center your telescope on the comet, first center Jupiter. To keep from spoiling your night vision, do this with the aperture stopped down to half an inch or less or while using a very dark neutral-density filter.

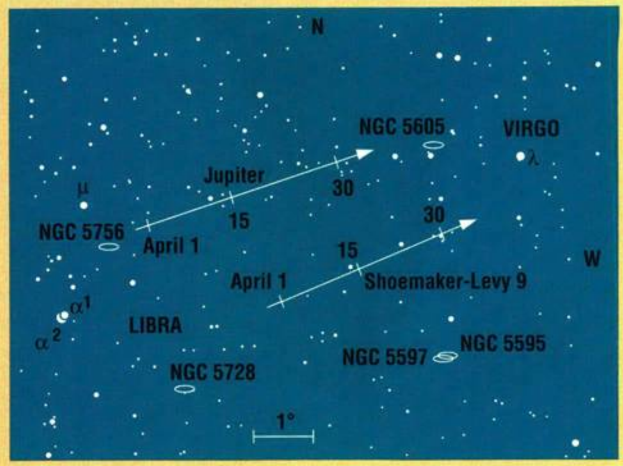
Choose an eyepiece that provides an exit pupil of about 2 millimeters. That much power will attenuate the background light below the level your eye can detect. Also use an eyepiece that has a small number of optical elements, such as a good Plössl or orthoscopic, to minimize the amount of light the elements absorb. Once you've done all that, you may still not spot the comet, but at least you'll have given it your best shot.

COORDINATES FOR COMET SHOEMAKER-LEVY 9

On this Date	Offset from Jupiter West in R.A.	Offset from Jupiter South in Dec.
Apr. 1	9m11s	1°18.2'
Apr. 6	9m04s	1°16.7'
Apr. 11	8m55s	1°15.0'
Apr. 16	8m45s	1°13.1'
Apr. 21	8m34s	1°11.0'
Apr. 26	8m21s	1°08.7'
May 1	8m06s	1°06.3'

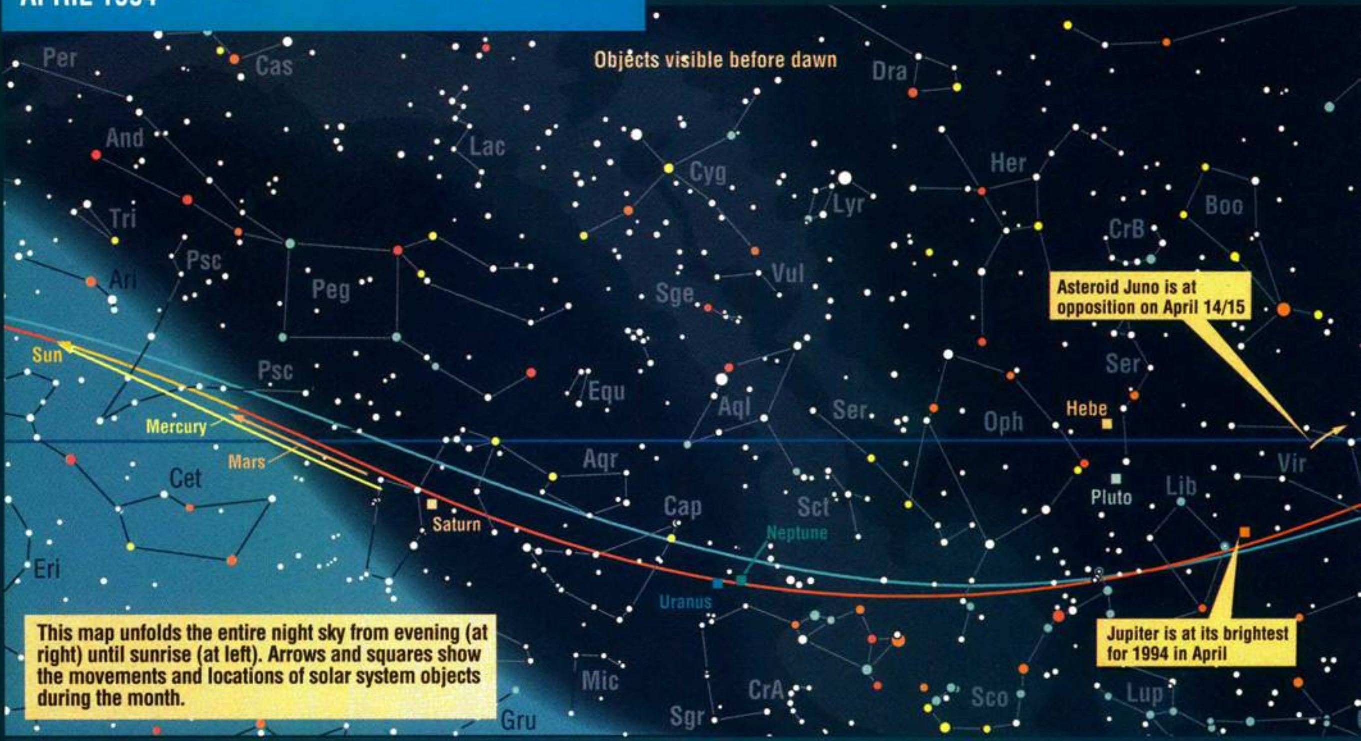


H. A. Weaver and T. E. Smith/STScI and NASA



SKY ALMANAC

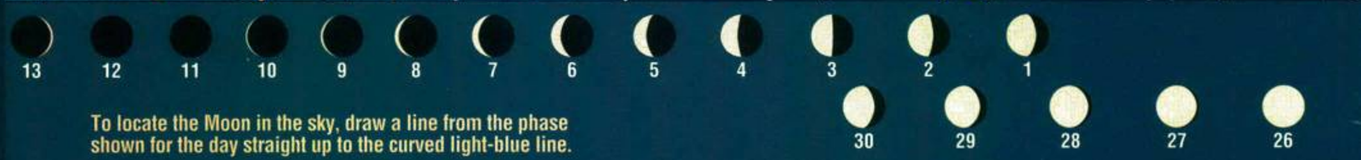
APRIL 1994


Objects visible before dawn
Per
Cas
Dra
And
Lac
Cyg
Lyr
Her
Boo
Tri
CrB
Psc
Ari
Peg
Vul
Sge
Sun
Psc
Equ
Aql
Ser
Ser
Oph
Hebe
Mercury
Mars
Cet
Saturn
Aqr
Cap
Sct
Neptune
Pluto
Lib
Vir
Eri
Uranus
Mic
CrA
Sco
Lup
Gru
Sgr

Asteroid Juno is at opposition on April 14/15

Jupiter is at its brightest for 1994 in April

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.


13
12
11
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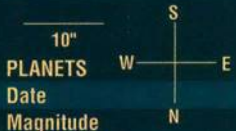
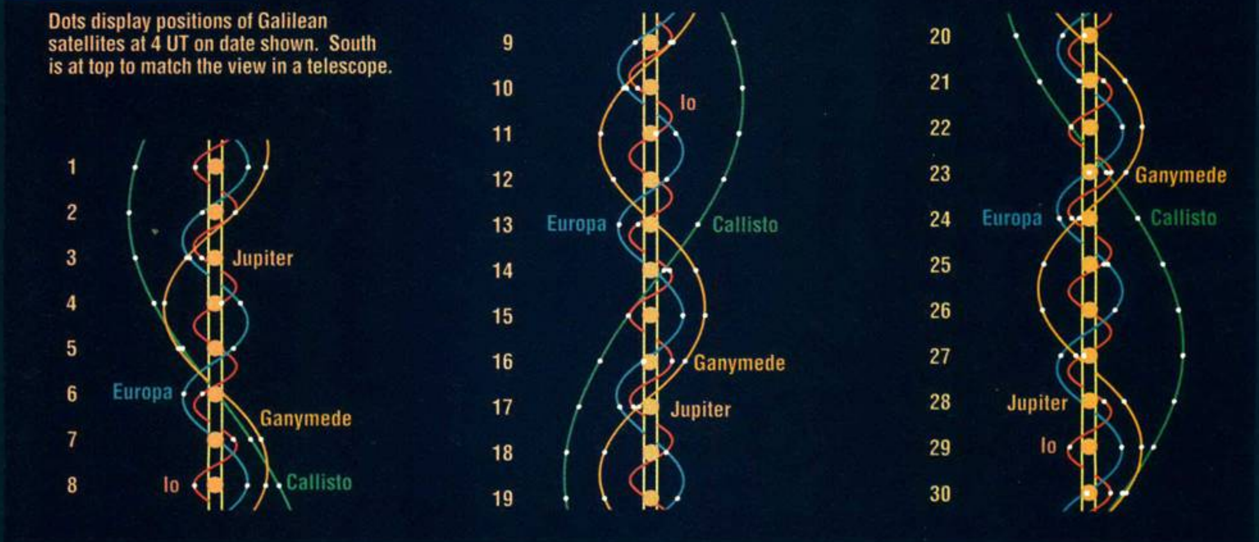
30
29
28
27
26

To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved light-blue line.

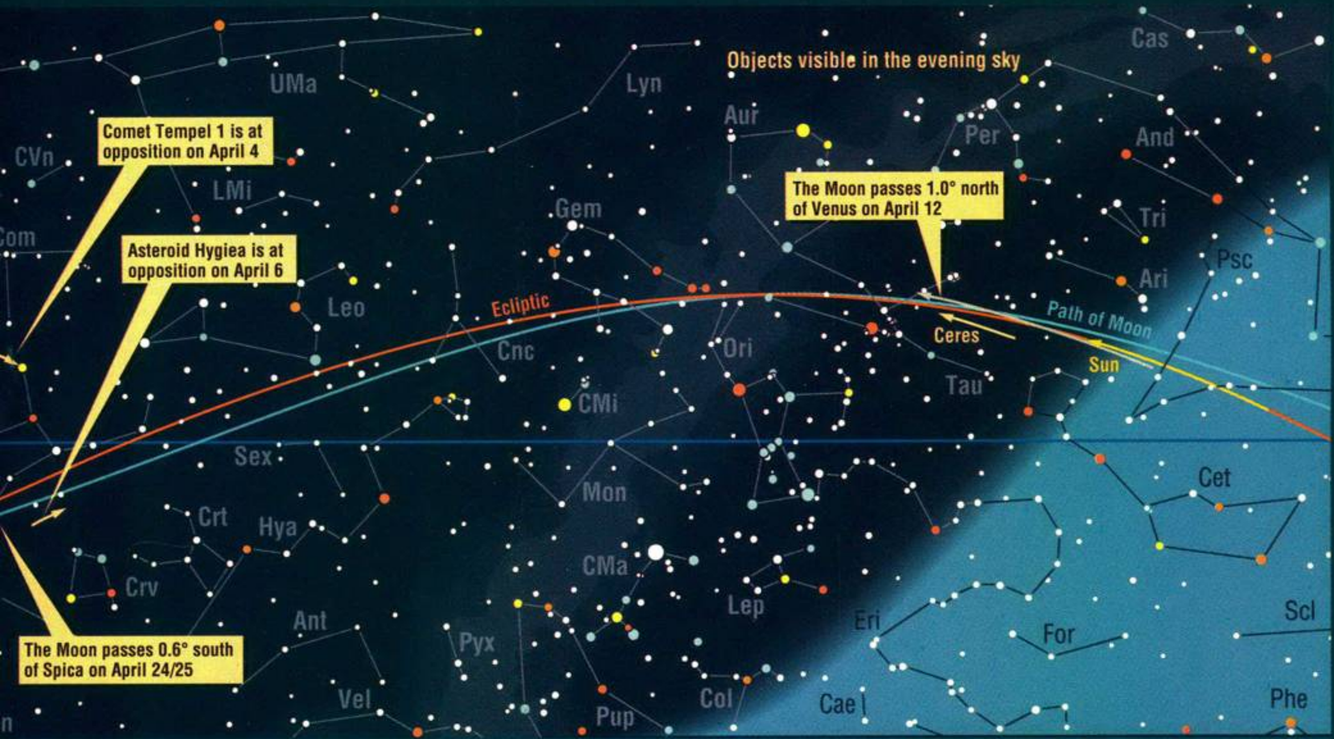


PLANETS	MERCURY	MERCURY	VENUS	MARS
Date	April 1	April 15	April 15	April 15
Magnitude	0.0	−0.6	−3.9	1.2
Angular Size	6.1"	5.3"	10.7"	4.2"
Illumination	71%	87%	93%	98%
Distance (AU) from Earth	1.098	1.259	1.554	2.229
Distance (AU) from Sun	0.457	0.400	0.720	1.382
Right Ascension (2000.0)	23h14.4m	0h37.5m	2h55.4m	0h02.7m
Declination (2000.0)	−7°25'	1°39'	16°43'	−0°52'

JUPITER'S MOONS



Dots display positions of Galilean satellites at 4 UT on date shown. South is at top to match the view in a telescope.

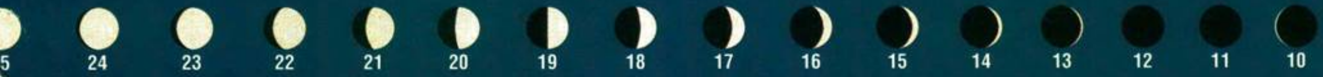

Objects visible in the evening sky
Cas
UMa
Lyn
Aur
Per
And
CVn
LMi
Gem
Tri
Com
Psc
Leo
Ari
Ecliptic
Path of Moon
Ceres
Cnc
Ori
Sun
Tau
CMi
Sex
Cet
Mon
Crt
Hya
CMa
Crv
Lep
Ant
Eri
Scl
Pyx
For
Vel
Col
Cae
Phe
Pup

Comet Tempel 1 is at opposition on April 4

Asteroid Hygiea is at opposition on April 6

The Moon passes 1.0° north of Venus on April 12

The Moon passes 0.6° south of Spica on April 24/25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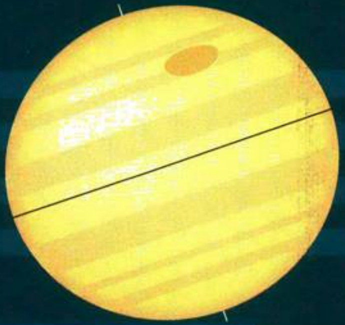
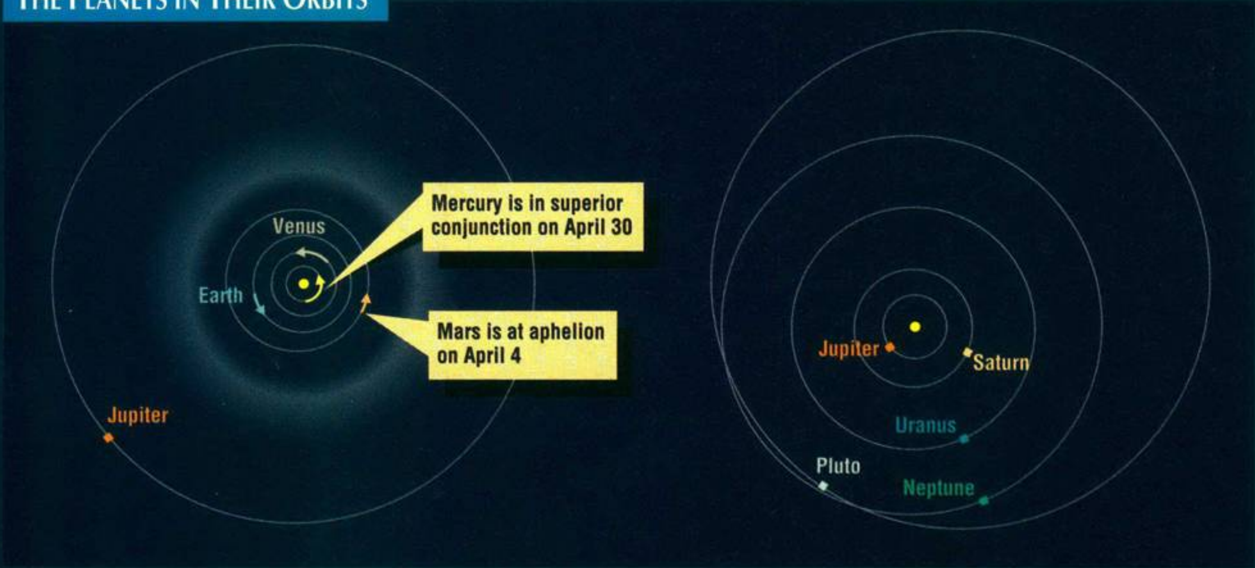
JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
April 15	April 15	April 15	April 15	April 15
–2.5	1.1	5.7	7.9	13.7
44.1"	15.9"	3.6"	2.2"	0.1"
100%	100%	100%	100%	100%
4.465	10.421	19.649	30.136	28.952
5.432	9.752	19.650	30.179	29.776
14h39.1m	22h44.1m	19h53.7m	19h40.5m	15h54.3m
–14°02'	–9°40'	–21°22'	–20°48'	–5°36'



THE PLANETS IN THEIR ORBITS


Venus
Earth
Jupiter
Jupiter
Saturn
Uranus
Pluto
Neptune

Mercury is in superior conjunction on April 30

Mars is at aphelion on April 4

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Focuser 682 2"	100
Finder brkt-8x50	20
Finder 544-8x50	70
Finder 545-8x50	70
Finder 637-6x30	50
Finder 957-9x60	100
Filter set of 4	50
Filter set of 8	90
Filter set of 12	130
Filter ND96 1.25"	16
IBM software-200	100
Illum 12mm w/cord	80
Illum 12mm-wless	100
Illum 9mm w/cord	110
Illum 9mm-wless	130
Lenshood 8"	109
Lenshood 10"	124
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Nebula 908N	90
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Paracorr 2"	214

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FOR SALE or **TRADE.** Complete set of ASTRONOMY, most in binders. Make offer or trade for a late set of eyepieces. Contact Ed Case, 4495 Piedras Street, Cocoa, FL 32927 or (407) 632-2922.

ANNOUNCEMENT. The Spyglass Network, a national network of small scope lovers, would like to hear from you. Just getting started? Active small scope user? Fond memories and willing to help? Please join us. Lively newsletter, no dues. Contact Gary Likert, 1203 Highway 25, Gallatin, TN 37066.

FOR SALE. Tele Vue Genesis plus finder with 26mm Plössl, 16 mm Nagler and full aperture glass solar filter with Super Polaris mount. Like new, two years old; $1,400 plus shipping. Contact Billy Preston, 54 Armstrong Rd, Sussex, NJ 07461, (201) 875-6560.

FOR SALE. 11x80 Celestron binoculars with case and strap; $225, matching tripod; $75, and one Celestron 12 mm Ortho ocular; $30. All like new and postage paid. Contact Omar Zuhdi, 2303 Robinwood Place, Shawnee, OK 74801, (405) 275-6052.

WANTED. Poster called "Star Trails around the South Celestial Pole" (has 3.9-meter AAO dome in foreground). Interested in finding David Malin photo published by Hansen Planetarium. Does anyone know how or where I can purchase these items? Interested in any leads. Contact Karenza Burk, R.M.B. 210, Creswick, Victoria 3363, Australia.

FOR SALE. Back issues of ASTRONOMY from Jan. 1978 to Dec. 1993 (missing Jan., Feb., April, and Aug. 1990). All in good to excellent condition; $200 plus postage. *Star and Sky* magazine, Jan.-July and Dec. 1979, Feb. and May-Dec. 1980, and Jan. 1981; $100 plus postage. *Deep Sky* magazine, Dec. 1977, Jan.-Dec. 1978, Jan.-May and July 1979, Jan., Nov., and Dec. 1981, Jan.-May 1982, Winter, Spring, Summer 1983, Spring, Summer, Fall 1985, and Summer and Fall 1989; $150 plus postage. Contact George Adornato, (702) 647-7908.

FOR SALE. Broadhurst Clarkson, London, 4" f/15, brass, altazimuth mount, oak tripod, built 1954. Best offer over $2,000. Contact Allan Baculis, (813) 397-5321.

FOR SALE. Questar Duplex, Zerodur mirror, Starguide, illuminated reticle, Dakin, tubes, etc.; $3,100. Contact Larry Fischer, (913) 273-0401.

FOR SALE. Odyssey 8 with many extras and upgrades; $375 pick up only. Contact Dr. Charles Bagdade, 125 Town Line Road, Vernon Hills, IL 60061, (708) 367-4890.

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Orion Deep Space Explorer telescopes were featured in an in-depth article in ***Astronomy*** magazine (12/93), and in the ***Sky & Telescope*** article *"Choosing a Low-Cost Telescope"* (12/93) which reviewed many entry-level telescopes including a Meade 6" Starfinder and Coulter 10" Odyssey.

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Astronomy

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The highest-performing complete optical systems available. We guarantee, and impartial reviews confirm, that Deep Space Explorer optics equal or exceed in performance those found on any comparable competitive telescopes.

"Optical performance was very good—superb for the price. At 175x we judged the planetary images the best of all the other designs of telescopes tested..." ***Sky & Telescope***

"During star tests the Explorers' optics exhibited a clear Airy disk and inner diffraction ring with little sign of common aberrations [which] indicated to me that these scopes were performing to a high standard...an outstanding level of optical quality from telescopes this affordable." ***Astronomy***

Our superb hand-figured optics out-perform similar sized and even larger-sized competitive scopes!

First-rate eyepiece — standard equipment. While most other scopes provide a cheaper, lower performance eyepiece, we include a superb fully coated four-element 25mm Sirius Plössl eyepiece. *"The Sirius eyepiece produced high-contrast, ghost-free images. It's great to see such a fine-quality eyepiece included as standard equipment on any entry-level scope."* ***Astronomy.*** *"Budget $50-$90 for each good eyepiece"* ***Sky & Telescope***

Quality machined aluminum low-profile helical focuser for brighter images, superior ease of focusing, durability. It's durable aluminum – not plastic like most others use. Our low-profile design results in a larger fully-illuminated field or smaller secondary mirror obstruction than models with tall rack-and-pinion focusers. Featherlight-touch focusing is much more precise, too. Focus is effortless and is easily done without upsetting the positioning of the telescope—a tricky feat with stiff competitive focusers.

Low Diffraction Stay-Put Secondary Support. Our factory-set no-hassle innovative single stalk secondary support (on 6" & 8" models) has *four times less diffraction* and eliminates *seven* potential misadjustments compared to conventional four-vane "spiders" found on competitive models.

Counterbalance Mounting Point. Dobsonians are sensitive to changes in balance caused by heavy eyepieces or added finder scopes. We provide a unique method of attaching any required balance weight—effortlessly.

Acclaimed Smooth-Motion Dobsonian Mount. Our innovative (and imperfectly imitated!) cabinet-quality mount is a masterpiece of clean design.

"The motions ... were extremely smooth. [It] exhibited just the right amount of friction...there was almost no wobble or play." ***Astronomy***

"The mount was sure and solid, and its motions were smooth in both axes. It responded to mild hand pressure for aiming, and when released the telescope stayed where it was pointed." ***Sky & Telescope***

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Orion is the #1 source for Celestron products! Our low, low prices can really save you a bundle! Whether you are considering a big telescope or a small one, or a binocular or accessory, chances are Orion has just what you are looking for. Celestron telescopes are available with a variety of mounts, including German-style equatorial or fork mounts and with a wide range of available drive systems. Our free catalog has a huge selection of models in all price ranges, available for immediate delivery!

TeleVista II 60mm Refractor

Equally at home viewing the rings of Saturn or boats across the bay. Quality 25mm (28x) 1.25"eyepiece, all metal optical tube and yoke mount, finder scope, adjustable tripod, diagonal prism.

#9075 **$239** (8.97)

Sky Explorer II 60mm Refractor

Ideal for lunar and planetary study, plus it's a powerful terrestrial telescope. 900mm f.l, 6x30 finder; star diagonal ; two eyepieces, equatorial mount; setting circles; tripod; and lighted accessory tray.

#9076 **$344** (13.22)

SpaceProbe II 4.5" Reflector

Great 4.5" f/8 reflector, ideal for planetary and deep space. Equatorial mount, slow motion controls, setting circles. 6x30 finder plus 25mm (36x) and 9mm 1.25" eyepieces. Deluxe tripod.

#9078 **$399** (22.19)

Sky Explorer II 80mm Refractor

Perfect for planetary and lunar observation. Bigger equatorial mount than competitive models, two 1.25" eyepieces, 6x30 finder, star diagonal, deluxe tripod and accessory tray.

#9077 **$497** (32.66)

Quality Components For Building or Upgrading

Parabolic Primary Mirrors

Excellent hand-figured parabolic mirrors guaranteed to meet theoretical limits of resolution. Fine polished, coated twice: with Aluminum and Silicon monoxide. Very competitively priced!

Standard Primary Mirrors
Made from fine soda-lime plate glass, 1:8 thickness ratio. Guaranteed 1/8 wave. Sizes: 6" f/8, 8" f/6, 10" f/4.5, 12.5" f/6.

Pyrex Low Expansion Mirrors
Made from fine annealed Pyrex brand low expansion glass, 1:8 thickness ratio. Guaranteed 1/10 wave. Available with 94% reflectivity Enhanced Aluminum coatings. Sizes: 6" f/5, 6" f/8, 8" f/6, 10" f/4.5, 10" f/6, 12.5" f/6.
See catalog for pricing.

Elliptical Secondary Mirrors

Made from fine annealed Pyrex brand glass, aluminized and SiO overcoated. Guaranteed 1/10 wave accuracy. Available with standard or high reflectivity Enhanced Aluminum coatings. Nine sizes from 1.00 to 4.00" minor axis.
See catalog for pricing.

6x30 Achromatic Finder Scopes

6x30mm—Same unit used on $1000+ "big name" telescopes. With 2-ring bracket, fits scopes 6"-12".
#13023 (white) **$49.95** (3.41)

6x30mm Right Angle—90° prism for right-angle viewing. Includes bracket.
#13021 (white) **$64.95** (3.41)

Large Aperture Finder Scopes

These are high-quality finders at incredibly low prices! Fully coated wide field achromatic optics with adjustable focus. Precision crosshairs. White or black enameled metal tube.

8x50mm—2.7x light grasp of 30mm models. Bright 6.25mm exit pupil.
#7090 (white) #7094 (black) **$64.95** (3.41)

8x50mm Illuminated—Wireless illuminator with adjustable brightness.
#7092 (white) #7096 (black) **$89.95** (3.41)

9x60mm — 44% more light grasp than 50mm models.
#7091 (white) #7095 (black) **$89.95** (3.41)

9x60mm Illuminated—Wireless illuminator with adjustable brightness.
#7093 (white) #7097 (black) **$129** (3.41)

Mounting Brackets for 50 & 60mm Finders
Unique sliding dovetail design. Super high quality. Fits any scope 6" and over including Celestron & Meade SCs.

8x50mm bracket #5040	**$34.50** (2.45)
9x60mm bracket #5041	**$39.50** (2.98)

Rack-and-Pinion Focusers

Finest in their class! Diagonal-cut plated brass racks, oversized knurled knobs, long focus travel.
1.25" #13007 **$49.95** (2.98)
2.0" includes 1.25" adapter. #13003 **$89.95** (3.95)

Low-Profile Focusers

Perfect for fast optical systems. Ideal replacements for "Odyssey" scopes.
1.25" #13014 **$39.50** (2.45)
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Huge Selection of Astronomy Binoculars

50mm Orion Observer™ II Binoculars — 7x, 10x, & 12x

Fine quality, moderately priced binoculars, excellent for both astronomy and daytime observation. Fully coated optics, unique hand strap for a secure and comfortable grip. Include case and straps.

7x50 #9643 **$89.50** (4.44)
10x50 WA #9644 **$94.50** (4.44)
12x50 WA #9645 **$89.50** (4.44)

50mm Explorer™ Binoculars

High performance large diameter binoculars with BAK-4 prisms and multi-coatings. Great for both astronomy and daytime observation. Comfortable ergonomic body design. Include case and straps

7x50 #9306 **$117** (4.44)
10x50 #9308 **$127** (4.44)

10x50 Orion UltraView™

The perfect binocular for eye and sunglass wearers. Extra-long 22mm eye relief and unique rubber pop-down eyepiece guard allows viewing with or without eyeglasses. Fully multi-coated optics provide high light transmission and maximum contrast compared to standard coated types. BAK-4 prisms. Wide 6.5° field of view. Close focus 16'. Weighs 32 oz. Includes case and straps.

#9351 **$159** (4.95)

10x50mm Orion Vista™

Superb for long distance nature observation and astronomy. The image quality will amaze you even when compared to much higher priced binoculars. Fully multi-coated optics provide high-fidelity true color images without ghousting or other aberrations. Long 16mm eye relief and roll-back eyecups for eyeglass wearers. BAK-4 prisms. 5.3° field of view. Weighs just 28 oz. Includes deluxe hard carrying case, rain shield, lens caps, and straps.

#9353 **$219** (5.19)

Orion® 70mm FMC Giants

The standard for hand-holdable astronomy binoculars. Fully Multi-Coated. 33% lighter—weighs only 58 oz.—yet the same brightness and 7mm exit pupil as our 11x80 MC model. Superior 'BCF' body design. Includes: soft rubber eyecaps, tripod mounting adapter, durable hard carrying case, lens caps and straps.

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80mm FMC Giant Binoculars

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11x80 MC- Brightest, widest field available. Ideal for deep-space observation under dark skies. Hand-holdable. #9502 **$389** (8.05)

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Gigantic, almost 4" lenses gather 156% of the light of 80mm binoculars. Individual eyepiece focus, fully Multi-Coated optics and BAK-4 prisms. Tripod mounting plate, metal-clad case. Weight 7.5 lbs., height 13.5".

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With patented unbreakable latches, die-cut foam inserts. (Inside Dimensions shown)

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Other sizes available for scopes 3.5" to 14"—See our catalog for details

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Gently replaces lost heat, a sure-fire cure for dew problems.

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DC #3503, AC #3504 **$47.95** (2.98)

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DC #3506, AC #3508 **$54.95** (2.98)

11" Dew Zappers—fit all Celestron 11" SCs
DC #3510, AC #3512 **$59.95** (2.98)

Scope Saver Telescope Covers

Keep the dust and dew away with these waterproof nylon covers; drawstring closure with cord lock.

8" Model #15130 **$33.95** (2.43)

10"-11" Model Fits Meade 10" and Celestron 11"
#15131 **$39.95** (2.43)

Now available for Deep Space Explorers!
Ask about other sizes.

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Standard Model—Adjustable height center column and padded seat.
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Deluxe Model—Built for professional musicians. Extra heavy duty.
#5934 **$89.95** (8.02)

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An essential accessory for astronomers. Choose from our wide selection.

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For prime focus or eyepiece projection astrophotography.

.965" #5268 **$26.95** (2.98)

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Hybrid 1.25"/.965" #8782 **$28.50** (2.98)

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Allows variable projection distances during eyepiece projection photography. For 1.25" eyepiece holders.

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Attaches to your photo tripod pan head. 2 slow motion control knobs to make precision adjustments in altitude and altazimuth. Very handy for tracking planets, the Moon, etc. with refractor telescopes and small spotting scopes. Attaches with a standard 1/4-20 thread.

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Extension Cable for Slow Motion Control

12 3/4" flexible cable, for tracking at high powers. Buy 2, one for each axis.

#5014 **$15.95** (2.43)

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For high powered photography with your Meade, Celestron 4", 8", 10", 11", 14" Schmidt-Cassegrain.

Standard Tele-Extender #5125 **$27.95** (2.98)

Variable Tele-Extender #5127 **$37.95** (2.98)

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Threads to rear cell of telescope, requires t-ring for your camera model.

for SC #5116 **$26.50** (2.98)

for C-90 #7115 **$29.95** (2.98)

T-Rings

Available for many different camera types, call toll-free or see our catalog for your particular model.

45° Erect Image Diagonal Prisms

See the world as it really is with Orion's 45° erect image diagonal. Ideal for all refractors and compound telescopes used for terrestrial viewing.

1.25" Diagonal #8790
.965" Diagonal #8791
Hybrid 1.25"/.965" Diagonal #8792

$44.95 (3.45)

90° Star Diagonal Prisms

Orion's multi-coated diagonals let you view at a right angle from the direction your telescope is pointing. The image is backward. Ideal for refractors and Schmidt-Cassegrains used for astronomical viewing.

1.25" Star Diagonal #8763 **$46.95** (2.98)

.965" Star Diagonal #8761 **$28.95** (2.98)

Hybrid 1.25"/.965" Star Diagonal #14008 **$31.50** (2.98) (2.)

2" Prism/Mirror Diagonals

2" Prism Diagonal–Absolutely the finest quality multi-coated 2" prism for highest light transmission.

For refractors #8770
For Schmidt-Cass. #8771 **$199** (4.71)

2" Mirror Diagonal– Affordable, high-quality star diagonal.

For refractors #8773
For Schmidt-Cass. #8772 **$99.95** (3.45)

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Let Sky Wizard do the work, while you relax and have fun observing!

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- Powered by a single 9v battery. Weighs just 6 oz!

Sky Wizard Model 1
Includes the Messier Deep Space Catalog of 110 objects, 28 bright stars, and the planets. #7801 **$199** (4.11)

Sky Wizard Model 2
Huge 2100+ object database, plus a user catalog to store 27 objects of your choice. #7802 **$319** (4.44)

Sky Wizard Model 3
Gigantic 10,000 object database, expanded subject descriptions, RS-232 port. #7803 **$469** (6.78)

Complete system requires Sky Wizard Model 1, 2 or 3 and a telescope installation package, sold separately.

Installation Packages
Includes 2 encoders, all required mounting hardware and brackets, connecting cables, and complete illustrated instructions.
Installation packages are available for most telescope models. Call for details.

starting at **$177** (5.29)

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Allows you to observe a guide star during photography. Multi-coated.

#5144 **$69.50** (3.45)

Orion UltraGuider

Wide-range lateral prism adjustment; precision helical focusing; adjustable camera focal plane position.

#5139 **$119** (4.19)

110v Motor Drive for Refractors

Fits Orion equatorial mounts, many others. Plugs into any standard AC outlet.

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12 Amp Hour Porta Pac Battery

Ideal for high power-consuming accessories. With carrying case. Weighs only 10 lbs.

#2354 **$109** (8.97)

Eyepieces & Barlows

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1

See Our Huge 76 Page Catalog for Many More! Including a Fantastic Selection of Name Brand Eyepieces!

New! **40mm ✧ *Sirius*™ Plössl**

1 ✧ *Sirius*™

Plössl 1.25" Eyepieces

Fantastic Name-Brand Quality Eyepieces at an Incredible Low Price!

You could pay nearly twice the price for "famous name" Plössl eyepieces, but we don't think you'll be able to tell the difference if you compare them to these fantastic eyepieces!

Sirius Plössls are top-quality, 50° apparent field (43° 40mm) eyepieces with extremely sharp images of impressively high contrast. Ideal for all types of telescopes. The Classic 4-element Plössl design is renowned for its fantastic performance and has become the standard by which all other eyepieces are compared.

The Fully Magnesium Fluoride coated optics are mounted in precision black anodized aluminum housings with chrome-plated brass 1.25" barrels for durability and precision fit.

25mm #8530, ***17mm*** #8531, ***10mm*** #8532, ***7.5mm*** #8533 **$59.95 ea.** (3.45)

New! ***40mm*** #8529 **$79.95** (3.45)

Case only #5911 **$12.95** (2.19)

SPECIAL OFFER–Buy Two or More and Save!

- *Any 2 .... $10 off (Save $5 ea.)*
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- *ALL 5 .... $85 off (Save $17 ea.)*

Bonus—Free case with purchase of 2 or more!

2 Superb Ultrascopic™ Eyepieces

Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7- element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Guaranteed to beat other brands selling for much more! Unsurpassed high-performance design!

Medium-High Power 5-element
20mm #8566, **15mm** #8568, **10mm** #8570, **7.5mm** #8572 **$74.95 ea.** (3.45)

Wide Field 5-element
25mm #8564 **$89.95** (3.45)
30mm #8562 **$94.95** (3.45)
35mm #8560 **$99.95** (3.45)

High Power 7-element *—Long Eye Relief*
5mm #8574, **3.8mm** #8576 **$84.95** (3.45)

3 Explorer .965" and 1.25" Eyepieces

These fine quality multi-coated eyepieces offer great performance at Orion's low direct-discount price. Three different optical designs are incorporated, to maximize efficiency in the various focal lengths. Black anodized, internally blackened, threaded for filters (except 40mm .965").

a *.965 Orthoscopic*
5mm #8580, **7mm** #8581, **9mm** #8582, **12.5mm** #8583 **$49.50 each** (2.98)

a *.965 Kellner*
18mm #8584, **25mm** #8585 **$37.50 each** (2.98)

a *.965 Achromatic Huygenian*
40mm #8586 **$37.50** (2.98)

b *1.25" Orthoscopic*
5mm #8500, **7mm** #8502, **9mm** #8504, **12.5mm** #8506, **18mm** #8524, **25mm** #8526 **$54.50 each** (2.98)

c *1.25" Kellner*
6mm #8536, **9mm** #8538, **12mm** #8540, **18mm** #8508, **25mm** #8510, **40mm** #8512 **$39.50 each** (2.98)

4 MegaVista 1.25" and 2" Eyepieces

These outstanding eyepieces feature a 7-element design and incredibly sharp, fully multi-coated optics. The long eye relief and integral rubber eyeguards make these ideal for eyeglass wearers. The extra wide field of view (67°-70°) provides stunning images, perfect for deep space observing.

10.5mm 1.25" #8552 **$164** (3.67)
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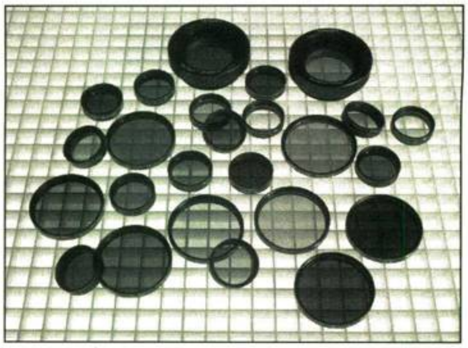

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PLANETARY PHOTOGRAPHY

HIGH IMPACT ASTROPHOTOGRAPHY

If you've wanted to try planetary photography, the perfect opportunity is at hand. Get ready to record this summer's unique collision of Comet Shoemaker-Levy 9 and Jupiter.

by Mark J. Coco

A comet crashing into a planet? You bet! For a period of five-and-a-half days centered on July 19, 1994, pieces of the fragmented comet Shoemaker-Levy 9 will slam into Jupiter. The effects from the resulting explosions in Jupiter's atmosphere may be subtle or they may include widespread atmospheric chaos visible in small telescopes on Earth.

You won't want to miss observing this event, and recording it photographically will provide a lasting record that you can share with friends. To do so, you'll need the right equipment for a technique called eyepiece-projection photography. This valuable technique also enables you to photograph other planets as well, so you can practice for the upcoming event not only on Jupiter but on the other bright planets such as Venus, Mars, and Saturn. For best results, try eyepiece-projection photography on nights when the seeing is steady. It will ensure that your photos are the sharpest they can be.

ASTRONOMY: Darla Evans

Because Jupiter is so small — a mere 44" across — you'll need to magnify the image so you can see details on your film. Size and clarity depend on two things: the size of your scope's mirror or lens and the focal length of your scope. The telescope itself must be on a stable equatorial mount with a smooth-running clock drive to track Jupiter.

But simply attaching a camera to your telescope's focuser will not provide enough magnification. This is where the eyepiece projection comes in. You'll need to insert an eyepiece between the telescope and camera and then focus the camera on the planetary image as it appears through the eyepiece, thus achieving high magnification.

To understand why you need such high magnification, let's look at an example. An image of Jupiter at the prime focus of a telescope with a 2,000mm focal length spans a mere 0.4 mm. If you use an eyepiece to boost the effective focal length to 40,000 mm, however, your image of Jupiter will measure 8.0 mm across, large enough to show intricate detail on the disk. (See box on page 66.)

You'll need a range of eyepieces, from 25mm focal length on the low-power end to 5mm on the high end, to experiment with image sizes and different planets. Generally the shorter focal lengths will produce images large enough to show pleasing detail. If possible, use orthoscopic or Plössl eyepieces. They offer crisp images and flat fields.

Choose your camera carefully. You'll need one with a B or T setting that allows you to keep the camera's shutter open without using the camera's batteries. (Planetary exposures are short, though, so you'll probably be fine if your camera does use battery power to hold open the shutter.) The camera must also have a removable lens so you can attach the camera body to a telescope. This excludes the point-and-shoot cameras that numerically dominate the market.

The best cameras are 35mm single-lens reflex (SLR) cameras with manual shutters. A few good choices are the Nikon FM2, Nikon F3, Olympus OM-4, Canon F1, and Pentax K1000. Or you might consider a used camera such as a Minolta SRT 101, Minolta SRT 102, or Nikon EM. You'll also need a cable release to open and close the shutter smoothly.

To connect your camera to the telescope you'll need a device called an eyepiece-projection adapter. This is a tube machined with threaded ends so you can attach it to the focuser on one end and camera body on the other. Various types of eyepiece-projection adapters attach to the several kinds of camera bodies. Check to see if your camera has a screw, bayonet, or other type of mount before you buy an eyepiece-projection adapter. Inside its tube sits the eyepiece that will project a planetary image onto the film plane.

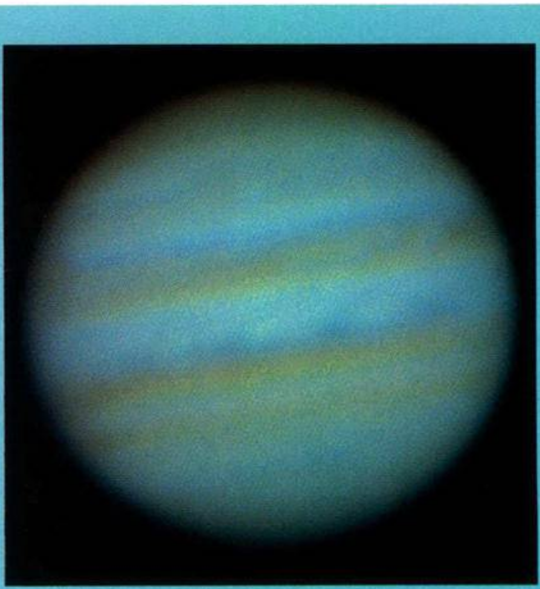
Besides choosing equipment, you'll also need to pick a film. The preferred choice is a fine-grain film, which will offer the best image quality. This means any film with an ISO rating of 200 or slower. For color photography consider Ektachrome 100, Ektachrome 200, and Fujichrome 100. For black-and-white film try T-Max 100, T-Max 400, or Tech Pan 2415 (which has an ISO rating of 125 when processed in D-19).

Somewhat less preferable is a fast film that promises shorter exposure times at a cost of less detail. Test a roll or two: You may be satisfied with the results despite the larger film grain. If marginal seeing is common at your site, you may want a fast film because it allows you to capture planetary images taken during moments of good seeing. Try Fujichrome 1600D professional slide film, Konica SRV 3200, or Kodak T-Max 3200.

Having chosen your equipment and film, you're ready to learn eyepiece projection. The first thing to do is polar align your telescope. Take your time getting polar aligned. You can use the declination drift method or a good polar alignment finder. (See "How to Polar Align Your Telescope," May 1992.)

Next, center Jupiter or another planet you want to photograph in the eyepiece. Because eyepiece projection produces a narrow field of view, finding Jupiter and centering it can be a challenge in itself. To make the job easier, align your finder with the telescope ahead of time. Use the highest magnification eyepiece you have to make the alignment as accurate as it can be. Before attaching your camera, be sure that Jupiter is centered in the eyepiece.

Once you choose the proper eyepiece and attach it to the telescope, you can add the eyepiece-projection adapter. Next, attach the camera body to the "working end" of the eyepiece-projection adapter. You may now need to rebalance the scope with counterweights on the front end and relocate the planet you are shooting. Take your time and recenter it in the viewfinder.



MIGHTY JUPITER will be struck by the fractured comet Shoemaker-Levy 9 in July. Photographing the effects of the collision in Jupiter's cloudtops should be possible with backyard telescopes.

Donald C. Parker

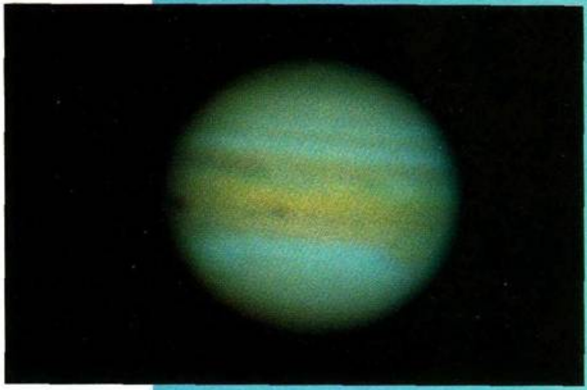
THE RED PLANET MARS offers a changing array of dusky markings within the reach of backyard astrophotographers.

Donald C. Parker

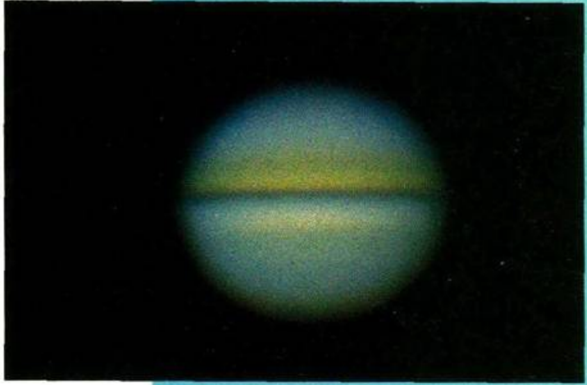
SATURN'S RINGS require longer exposures than the disks of Jupiter and Mars do, making capturing the Ringed Planet tricky.

Stephen Keene

DETERMINING IMAGE SCALE



Stephen Keene



C. Capen

With eyepiece projection, the f/ratio, effective focal length, and magnification of your telescope change. You need to know these to determine the image scale you'll be working with. You can calculate these values with some simple arithmetic. The first equation determines the effective f/ratio of your telescope during eyepiece projection.

$$\textbf{Effective f/ratio} = \textbf{telescope's f/ratio} \times \frac{D-F}{F}$$

D is the distance between the eyepiece and the film plane and F is the focal length of the eyepiece. The telescope's f/ratio is that of the telescope in normal use. Remember to keep units consistent: if you use millimeters to measure one thing, use it also for the others.

First determine the distance from the eyepiece to the film plane, the position of the film in the camera. This will vary, depending on adapter size and eyepiece design and focal length. Most 35mm cameras have an indicator on the outside of the camera body to show where the film plane lies. You'll need to measure the distance from the center of the eyepiece to the film plane.

Once you've determined the effective f/ratio, you're ready to compute the effective focal length. To do this, multiply the effective f/ratio by the lens or mirror aperture in millimeters.

Effective focal length = effective f/ratio x objective diameter

Let's look at an example. Suppose you have a 10-inch (254mm) f/7 reflector. We're using an adapter that separates the eyepiece and film by 165mm. Wiuth a 10mm eyepiece, we get an effective f/ratio of 108.5. Next, multiply this by the mirror diameter of 254mm. This yields an effective focal length of 27,600mm (27.6 meters).

Finally, after you have figured the effective focal length you are ready to calculate the magnification. Magnification is determined by the following:

$$\textbf{Photographic magnification} = \frac{\textbf{effective focal length}}{\textbf{50(mm)}}$$

The effective focal length used in this formula is that of the telescope computed for eyepiece projection. Continuing with our example, take the 27,600mm of effective focal length figured in the previous formula and divide it by 50 (50mm is used because this is the focal length of a normal photographic lens that produces no magnification). This gives us 550x.

You may now focus the camera. With a highly magnified image viewed through the camera, Jupiter tends to be a little soft or fuzzy. The best way to focus is to concentrate on the planet's limb and make gradual adjustments to the focus knob until the image is as sharp as possible.

If your camera has interchangeable focusing screens, try ground glass. This allows you to see the finest possible image for focusing. Accessories called Beattie Intenscreens are also good because they produce a brighter image than ground glass focusing screens. If your camera has a *split-screen focuser, ignore the split* screen and focus the image in the area surrounding it. Check the focus after each exposure. The seeing conditions may change or the focus may simply shift.

Once you have located Jupiter and focused its image, be sure the drive is tracking accurately. Get comfortable and monitor Jupiter for a few minutes. Ideally, it should stay in *the same spot within the field.* However, if your telescope is not properly balanced or if the drive is not tracking accurately, Jupiter will drift slowly. You can use the fast/slow buttons on the drive corrector to make adjustments.

However, you'll want to make most of your adjustments with the speed variance knob on the control box of your drive corrector. This allows you to increase or decrease the tracking rate of the drive very slightly. Because it's impossible to *guide during the exposure, the drive* needs to track as accurately as possible. If, after you adjust the speed, the drive still does not track accurately, try adjusting your scope's counterweights. If your drive can keep Jupiter stationary for a few minutes, you're ready to begin.

Taking the exposure can be tricky, even when the scope *tracks smoothly.* Because the image is magnified so much, releasing the shutter of your camera produces enough vibration to smear the image. To avoid this, use the "hat trick": You hold a black card right in front of the telescope to act as a shutter. The card prevents light from entering the telescope while you open the camera's shutter.

Once the shutter has been released and the vibration has damped out — usually after a few seconds — you can move the black card out of the way to begin exposing the film. (To calculate exposure times for your system, see the box at right.) Once the exposure is complete, return the card to the front of the telescope and close the camera's shutter. Hold the card a few inches in front of the telescope without touching the scope. Depending on the size of your telescope this may be a two-person job: One person holds the card while the other releases the shutter.

With the basics of the overall process covered, it's time to bring it all together and take some pictures. Begin by setting your camera's shutter to B or T. Then center your target in the field. Be sure the telescope drive is tracking accurately and Jupiter is in focus. Place the black card over the front of the telescope.

Open the shutter of your camera using a cable release and wait three to five seconds for vibration to diminish. Then remove the black card for the duration of your exposure. When the exposure is complete, replace the black card and close the camera's shutter. Advance the film and you are ready for your next exposure.

If you have an auto winder for your camera, use it to advance the film since it produces much less vibration than advancing the film by hand. Check the position of Jupiter in the view finder of your camera and the focus, and you are ready to take the next picture.

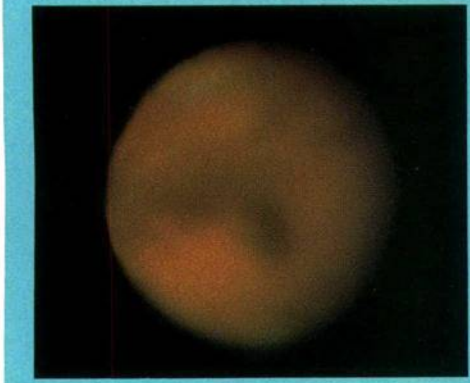
If your camera has an electronic shutter, be sure you have fresh batteries.

While the exposures for eyepiece projection are relatively short, the process is involved enough that it takes patience to master. The impending impact of Comet Shoemaker-Levy 9 and Jupiter — a once-in-a-lifetime event — is only several weeks away, so you'll want to start practicing the technique soon. By photographing Jupiter now you can produce good photographs that you can compare to those you take after the comet's collision. ☐

Mark J. Coco is an avid astronomer in the Los Angeles area. His last article was "Catch the Geminid Meteor Shower" (December 1993).

THE "EVENING STAR," Venus, presents a cream-colored, featureless disk. Though surface details are hidden by thick clouds, you can capture the planet's cycle of phases on film.

Mark J. Coco



NORMALLY TINY MARS presents surface markings large enough to photograph only when it is relatively close to Earth.

Mark J. Coco

JUPITER'S BANDS AND BELTS, so prominent visually, are easy to capture on film. Details such as satellites orbiting the giant planet (right) also appear on backyard photos.

Jack Zeiders

GETTING THE EXPOSURE RIGHT

You'll need to prepare for your eyepiece projection exposures by calculating the exposure time. Here's a simple formula to help you determine the approximate exposure time for Jupiter.

$$\textbf{Exposure time (in seconds)} = \frac{f^2}{A \times B}$$

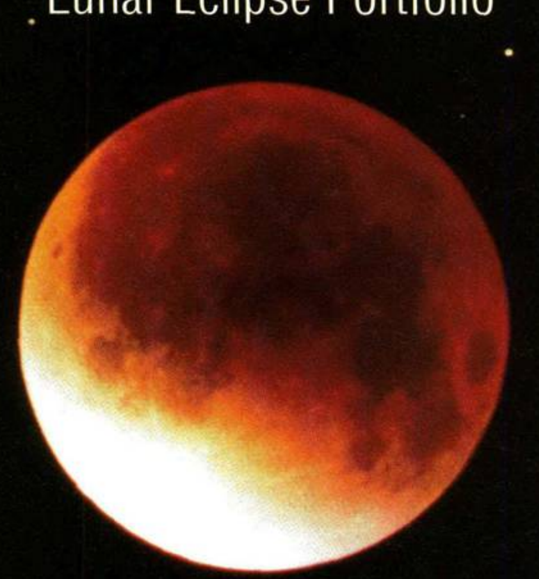
where f is the f/ratio of the telescope during eyepiece projection, A is the ISO rating of the film, and B is the relative brightness of Jupiter, which is 30.

Let's continue with an example. First, take the f/ratio of 108.5 and square it to get approximately 11,770. Now, multiply the film speed, say ISO 100, by the relative brightness value of 30. This yields 3,000. Finally, divide 11,770 by 3,000 to get 3.9. Round this off to 4 and you have the correct exposure time in seconds.

Once you have computed the correct exposure time, take two or three exposures of the same duration, because seeing conditions can change during an exposure or a gust of wind can shake the telescope. Two or more photos of the same duration will improve your chances of getting a good photo. Also, take exposures at $^1/_2$ and 2x and 4x the basic "correct" exposure. This will help pinpoint the best exposure time.

Keep a detailed record of the exposures you make. This list will guide you in future photography.

Lunar Eclipse Portfolio



Ken Rubin

November's Colorful Eclipse

Earth's shadow colored the Moon gray, red, yellow, brown, and blue as our satellite swept between the Pleiades and Hyades.

by David Bruning

"The most spectacular part of this eclipse was the way the light from the Pleiades, the Hyades, and Aldebaran seemed to be enhanced by the disappearance of the Moon. It was a spectacular sight," say John and Linda Sellechio of Warwick, Rhode Island.

Most of the several dozen reports we received before press time echoed these feelings that the total lunar eclipse on November 28/29, 1993, was beautiful. But observers' descriptions of the Moon's brightness and color varied immensely.

The Sellechios say that the eclipse appeared to them to be much darker than the December 1992 lunar eclipse. George Adornato of North Las Vegas, Nevada, seconded this report. He relates this was "the darkest lunar eclipse I've ever seen," adding, "When I viewed the eclipse through my 11x80 binoculars — Wow! — it was stunningly beautiful. I was thinking about selling my 11x80s but this lunar eclipse changed my mind forever. Viewing an eclipse through a telescope is beautiful but binoculars are better."

Ric Shanahan of Rowley, Massachusetts, also notes that this was a dark eclipse visually and that the red color seen in photographs was not as apparent to the unaided eye or through a scope. During mid-totality he showed his son the Crab Nebula (M1), a supernova remnant located near the eclipsed Moon in Taurus. He asks, "How many people have seen the Crab Nebula in a small scope with a Full Moon in Taurus?"

Anthony Amato, Michael Amato, and Joseph Csieh of West Haven, Connecticut, rate the early part of totality at 1.5 on the Danjon scale and the latter half of the eclipse at 1.8. The lunar eclipse scale developed by the French astronomer André Danjon rates a dark eclipse as 0 and a bright eclipse with an orangish color as 4. For comparison, they rated the December 1992 eclipse at 1.2. They saw the central part of the Moon as gray with the outer rim as rust colored.

Others saw the eclipse as very bright. Rob Donner, observing from the coast of Isla Vista, California, says "This was the brightest total lunar eclipse I've seen in years. The very light orange color was visible both to the naked eye and through the telescope, something I had not witnessed before."

Benjamin Gomes-Casseres watched the eclipse from the Amateur Telescope Makers of Boston clubhouse in Westford, Massachusetts. With 20 percent of the Moon yet to move into the dark center, or umbra, of Earth's shadow, he could tell that this was going to be a bright eclipse because he could still see the part of the Moon in the umbra. During the December 1992 eclipse the eclipsed part was invisible.

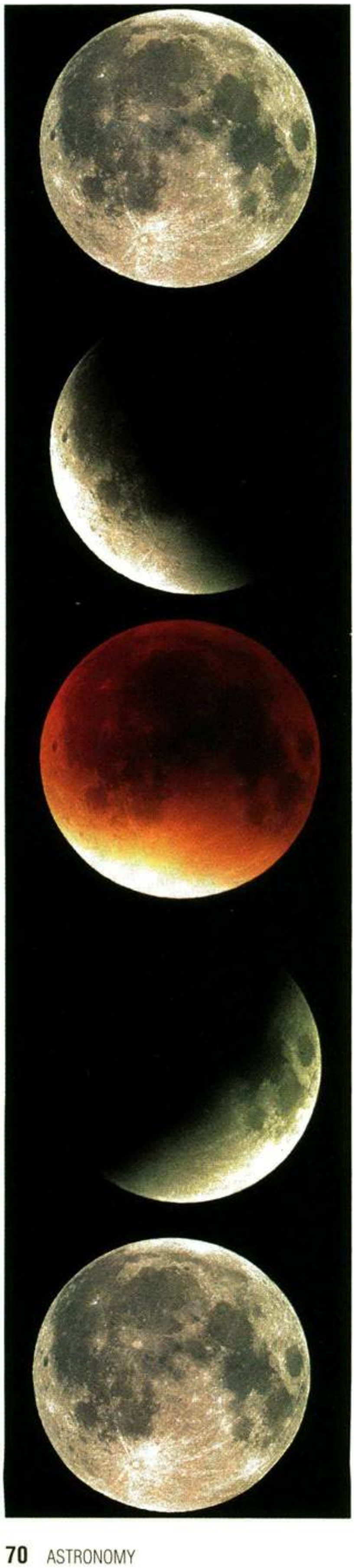
Another report of a bright eclipse came from Thomas Rankin and friends, who observed the event from a school parking lot in Staatsburg, New York. They remark, "Almost immediately after the Moon touched the umbra we could tell that this would be a bright eclipse. The eclipsed part of the Moon never disappeared from sight in the telescope as it did completely last year." They saw a hint of copper color and rated the eclipse at 3.5 on Danjon's scale. Perhaps the "highlight" of their evening came when a police officer with a bright spotlight asked what they were doing at the school. After they explained they were viewing the eclipse, he looked out of his car to see the sight.

Thomas Randall of Poughkeepsie, New York, also viewed the eclipse as fairly bright, rating the eclipse at 3 on Danjon's scale. He clearly saw with his unaided eyes that the eclipsed Moon had a reddish tint.

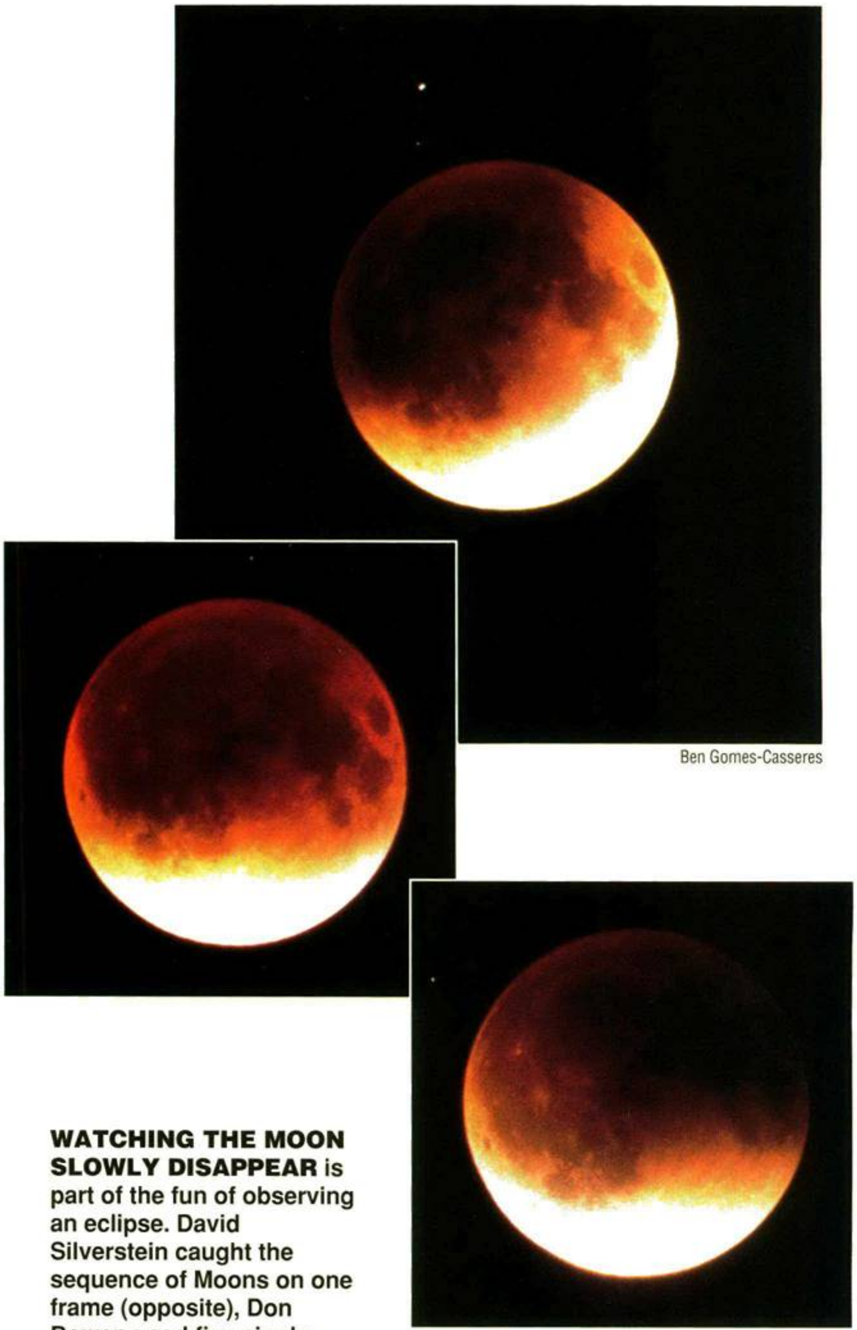
Not every New Yorker saw the strong reddish color that Randall did. For example, Michael Kitt of Ossining, New York, saw little color. Except for the extreme northern portion of the disk, which had a distinctly reddish hue, the Moon appeared to Kitt an ashen gray. Chuck McMurtrey of Round Rock, Texas, thought the Moon appeared a brownish hue instead of orange.

PHOTOS SHOW THE MOON COLORED RED with hints of yellow and blue during totality but many visual observers saw only shades of brown or gray.

Chuck Vaughan

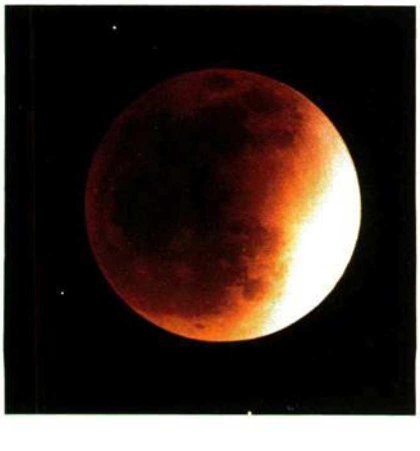


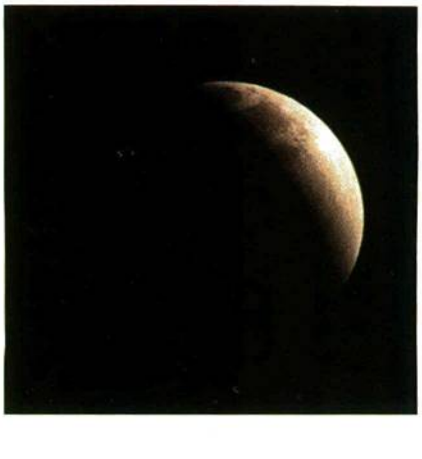
David Hanon

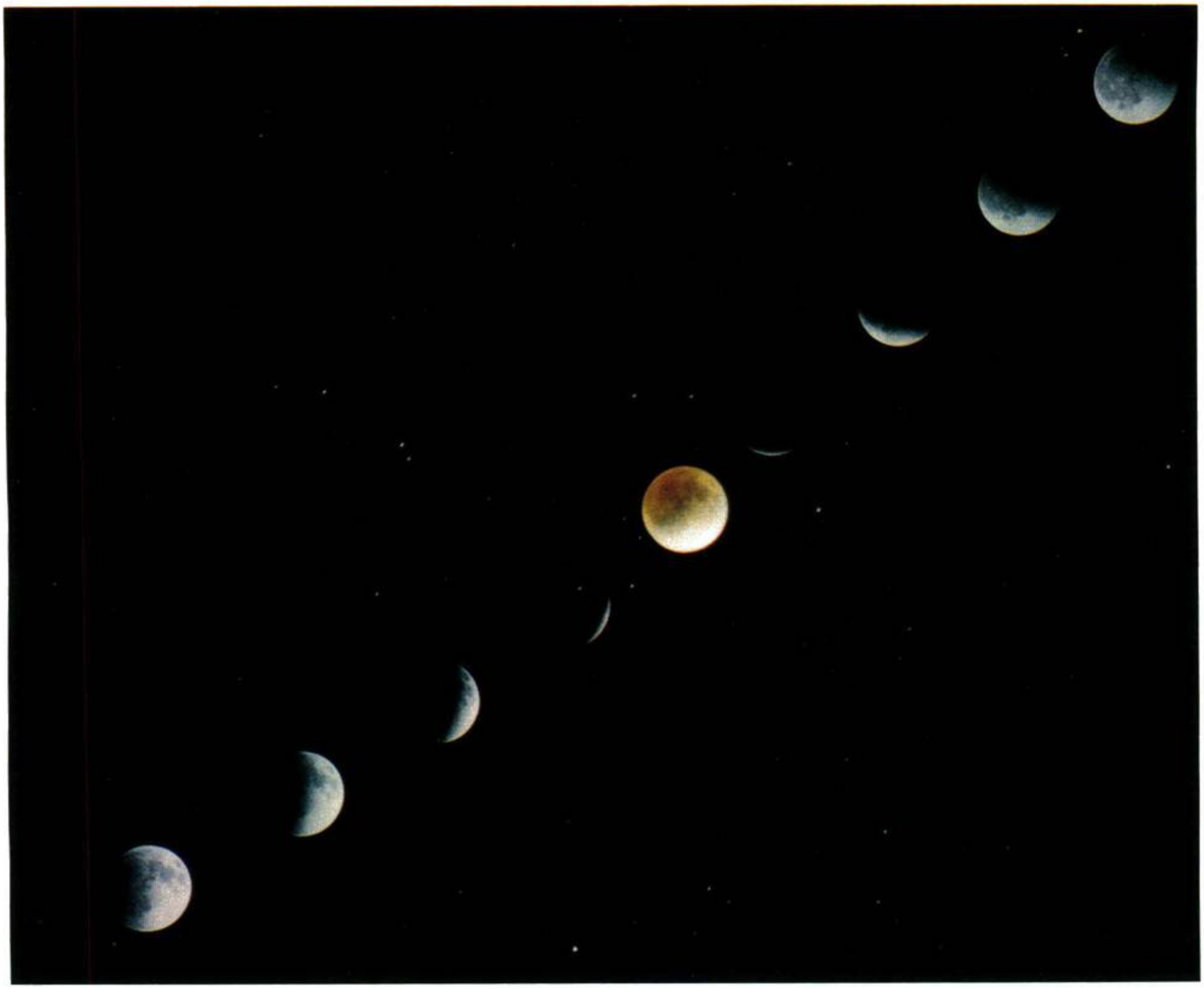


Ben Gomes-Casseres

WATCHING THE MOON SLOWLY DISAPPEAR is part of the fun of observing an eclipse. David Silverstein caught the sequence of Moons on one frame (opposite), Don Bowen used five single frames to capture the Moon's disappearance (below), and David Hanon composited five images digitally to present the history of November's eclipse (left). Ben Gomes-Casseres' photos (above) show how the bright rim traveled around the Moon's southern hemisphere during totality.





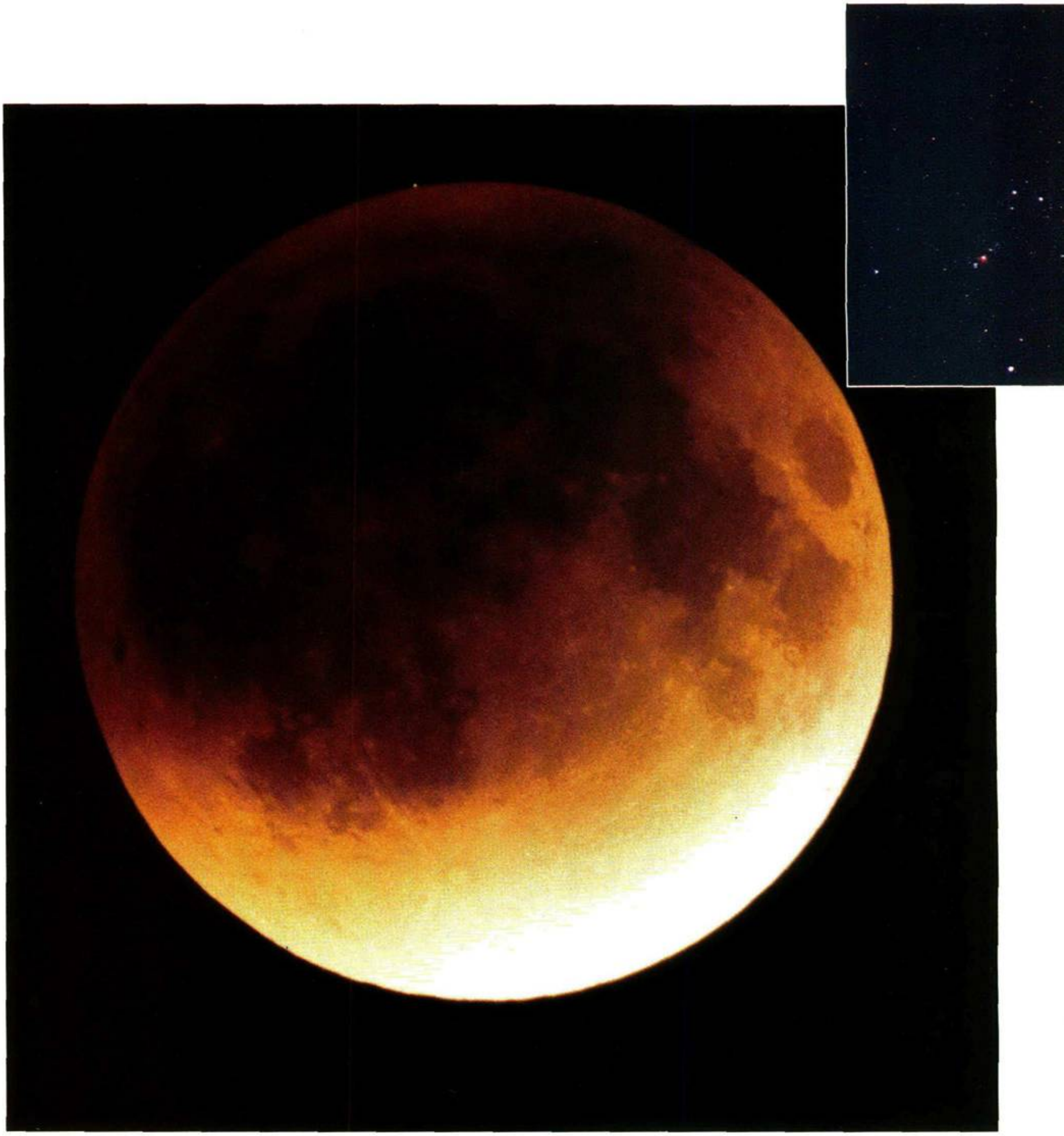


David Silverstein

Fred and Soile Espenak observed the eclipse from southern Maryland. They report that the Moon was less colorful than they expected. Most of it was gray with traces of brown and the southern limb appeared grayish white. The northern regions did exhibit traces of deep red, especially during the latter half of the eclipse. Fred gave the eclipse a 2 on the Danjon scale for its overall brightness, the easy visibility of lunar features, and the bright rim. But the coloration was closer to a 1 on Danjon's scale with the predominant grays and browns.

Other observers described a spectrum of colors. Chris Cook of Long Beach, California, notes that he saw a range of colors through his 8-inch Schmidt-Cassegrain. The northern limb appeared orange and the southern limb bluish white. In between he saw yellow, brown, and gray. Don Trombino of Deltona, Florida, saw a dark gray Moon with just a hint of copper color visually. But his photo of the eclipsed Moon showed a dark lunar center, a coppery or orange northern limb, and an unusual violet tinge in the southern hemisphere.

Sequence photos by Don Bowen



Dave Sewell

TRAVELING THROUGH TAURUS, the Moon passed in front of, or occulted, several stars. Dave Sewell's photo shows a star just before it disappeared.

While the debate about the brightness and color of the eclipse ranges among our readers, one feature seems constant. The Moon's southern limb appeared brighter than the northern limb.

Fred Espenak says, "What really struck me was that the total phase began and ended far more gradually than most lunar eclipses I can remember. I believe this was because the southern limb of the Moon remained very bright throughout totality." Benjamin Gomes-Casseres described the bright rim as if the southern limb seemed to lie almost outside the umbra.

The bright perimeter of the Moon tempts Michael Kitt to call this an "annular eclipse of the Moon." He says, "Just prior to the start of totality and again after totality ended, the Moon displayed its version of the diamond ring effect. My impression was that if the Moon had passed deeper into Earth's shadow instead of skimming one edge, this would have been a fairly dark eclipse."

Several things contributed to making the southern hemisphere so bright. First, the Moon just skimmed the southernmost part of the umbra of Earth's shadow. Second, the cratered highlands of the Moon's southern hemisphere can be twice as bright as the dark maria of

Jeffrey Pettitt

David J. Pontzer

Jerry Schad

THE PLEIADES AND HYADES FRAMED THE ECLIPSE perfectly as these pictures reveal. Jeffrey Pettitt's wide-angle shot includes Orion and Taurus (top left), Jerry Schad's photo captures the eclipsed Moon nestled between the Pleiades and Hyades (left), and David Pontzer's close-up shows the Moon and the Pleiades (above). Don Trombino captured an unusual violet tint during totality (below).

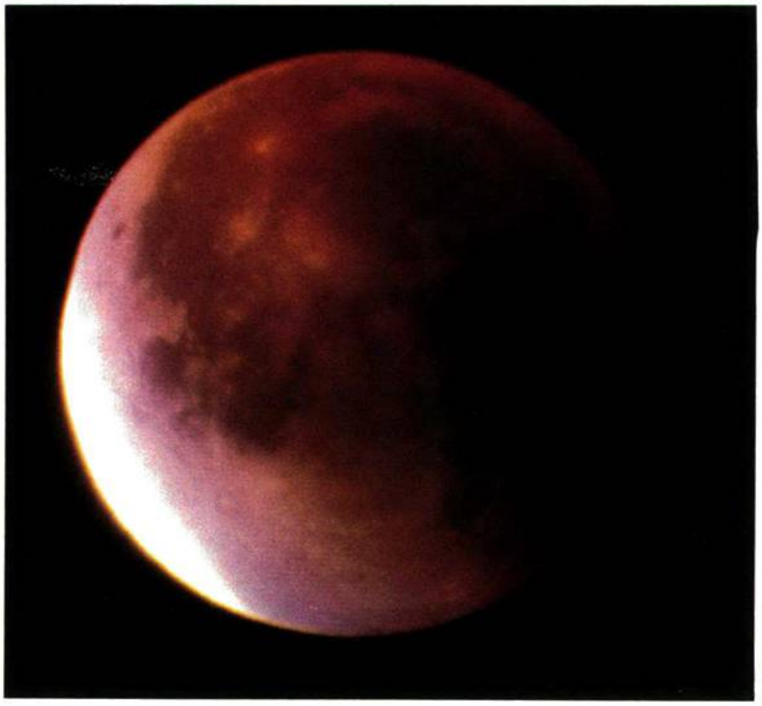
the Moon's equatorial regions and northern hemisphere. Third, some readers speculated that Earth's Southern Hemisphere has lower concentrations of volcanic dust and aerosols thrown into the atmosphere by Mount Pinatubo, helping to make the Moon's southern hemisphere appear brighter.

Many of us saw the eclipse through clouds. John Reilly of Tracy, California, had a hole in the clouds open up just at the end of totality. He grabbed some quick views and pictures of the eclipse before more clouds rolled in.

Greg Furtman of Webster, Wisconsin, says he was lucky to take photographs of the eclipse. Thick clouds covered his area until about 10 p.m. Then the skies cleared, just in time so he could watch the beginning of the umbral eclipse and about half of totality. Friends less than 60 miles away in all directions remained clouded out.

Chuck Vaughan notes that Northern California was not an ideal site from which to view the eclipse. He grabbed shots of the eclipse through holes in the clouds as one storm moved away and another started to move in. He says that visually the Moon showed just a hint of yellowish orange in its center, nothing like the deep orange seen in his photo.

Orange — brown. Bright — dark. However you saw the eclipse, the view of the eclipsed Moon set against the stars of the Pleiades and Hyades made this eclipse memorable. If you missed it or clouds blocked your view of totality, don't fret: April 1996 will bring another chance to see a total lunar eclipse from North America. ☐



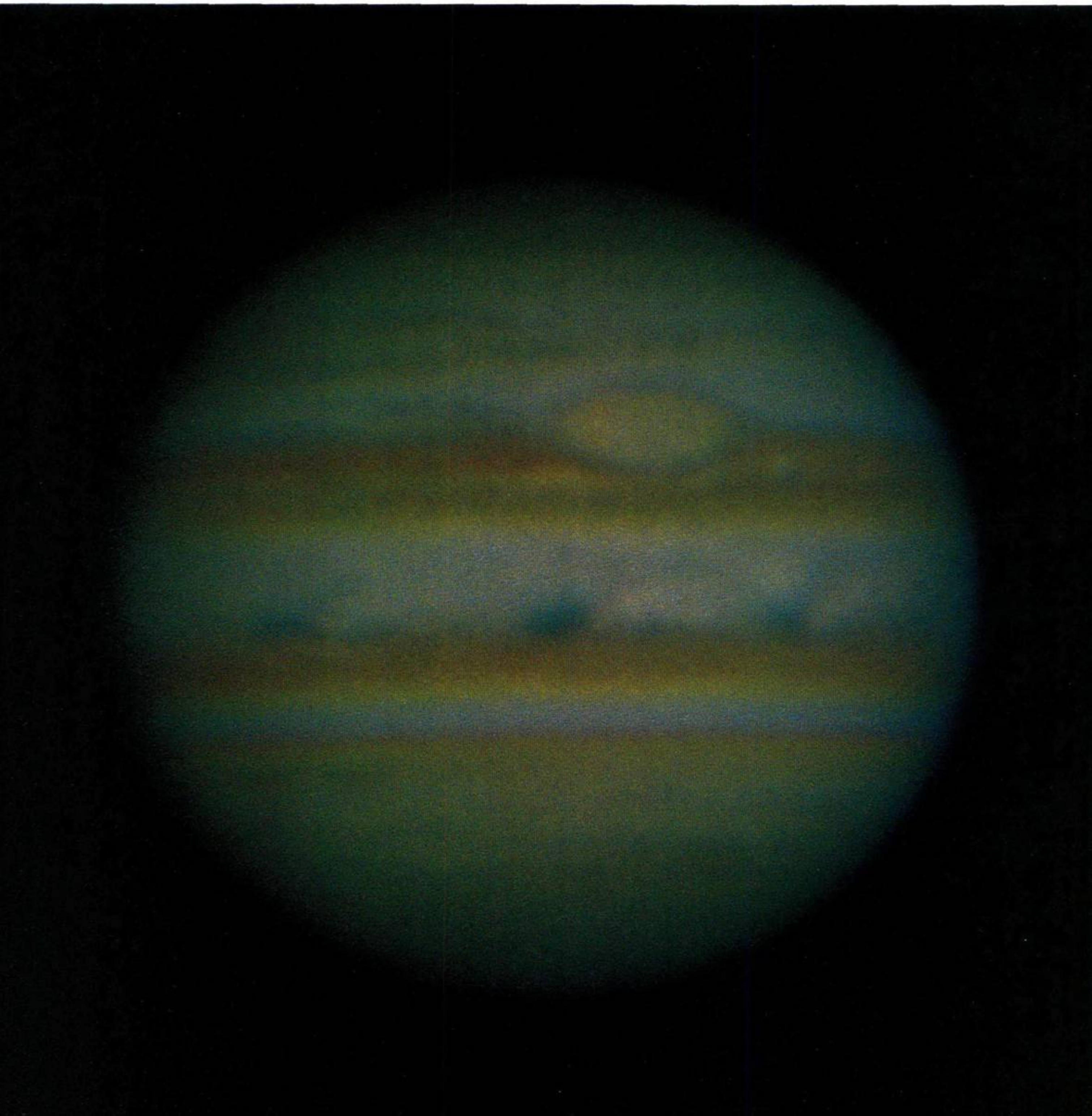
Don Trombino

PLANETARY OBSERVING

JUPITER'S MAGNIFICENT SHOW

As Comet Shoemaker-Levy 9 bears down on Jupiter, now's the time to get acquainted with this giant planet, so you can appreciate the effects of the impacts to come.

by José Olivarez



As you read this, the fragments comprising Comet Shoemaker-Levy 9 are hurtling toward Jupiter. Although they won't collide with the giant planet until next July, backyard observers should begin scrutinizing the planets. One reason is that in April Jupiter appears at its best for the year — presenting a large disk to telescopic observers and remaining visible all night long. But more important, you need time to become familiar with the intricate detail visible in the Jovian cloudtops. In July only those who know what Jupiter normally looks like will best observe the changes caused by the comet's impact.

The countdown to the Great Comet Crash of '94 now stands at three months, with the first pieces predicted to strike Jupiter on July 16 and the last pieces on July 22. Although the comet fragments will crash into the far side of Jupiter, out of range of Earthbound telescopes, the sites of the impacts will rotate into view within about 15 minutes. The impact sites will all lie at latitudes from –47° to –49°, slightly south of Jupiter's South Temperate Zone.

The normal cloud features that appear in the South Temperate Zone year after year are distinctive and long-lived. You can follow these spots and streaks, which can be either light or dark, for several weeks or months. But spotting them requires some observing skill and the use of a high-quality telescope and eyepieces.

BIG AND BRIGHT

After spending the end of 1993 and the first few months of 1994 in the morning sky, in April Jupiter becomes prominent in the evening sky. It reaches opposition on the 30th, when it lies opposite the Sun in our sky and thus rises at sunset, makes a high arc across the southern sky during the course of the night, and sets at sunrise. For backyard observers, opposition means Jupiter appears brighter and larger than at any other time of the year. At magnitude –2.5 at opposition, it outshines every object in the night sky except the Moon and Venus. At this time, the giant planet shows a 45"-diameter disk on which it is relatively easy to discern detail.

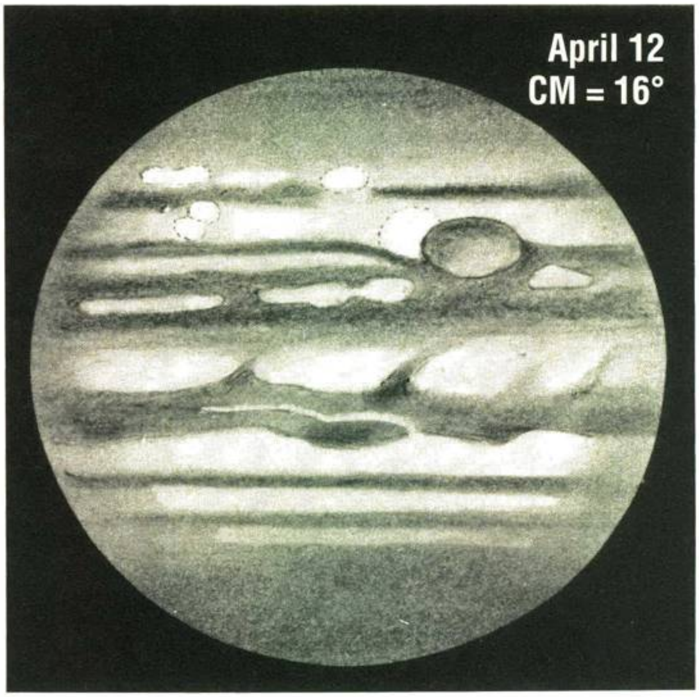
When Shoemaker-Levy 9 hits in late July, Jupiter will have faded a little to magnitude –2.1 and shrunk to an apparent size of 38". It then appears relatively low in the southwest and can be seen for only a few hours after sunset. The best time to observe will be between 9:00 p.m. and 11:30 p.m. local daylight time.

AN ACTIVE PLANET

As you will see in your telescope and as the Voyager spacecraft more vividly showed, Jupiter's atmosphere is marked by alternating bands and eddies of multicolored clouds and an active array of storm systems. The cloudtops are in constant motion, driven by the planet's rapid rotation, heat escaping from its warmer interior, and sunlight absorbed from above. Super-hurricane force winds, which typically exceed 360 kilometers per hour in the equatorial region and are even higher at Jupiter's north temperate latitude, also churn these clouds. They drive the cloud patterns that make Jupiter an everchanging spectacle to watch.

Stretching parallel to Jupiter's equator is a system of alternating dark belts and bright zones. The belts represent regions of low pressure while the zones represent regions of high pressure. The most prominent belts are the North Equatorial Belt, South Equatorial Belt, North Temperate Belt, and South Temperate Belt. The most obvious of all the zones is the Equatorial Zone, which separates the two dark equatorial belts.

All four belts were conspicuous toward the end of 1993. This marked a change for the South Equatorial Belt, which had been faint throughout 1992 and the early part of 1993. The belt began reviving in early April 1993 and was back to normal by the time Jupiter got too close to the Sun to observe last September.



Jean Dragesco

INTRICATE DETAILS ABOUND in the turbulent cloudtops of Jupiter's atmosphere. Sketching your eyepiece view of the planet is a great way to record Jupiter's belts and zones and the long-lived Great Red Spot.

A RED SPOT AND THREE WHITE SPOTS

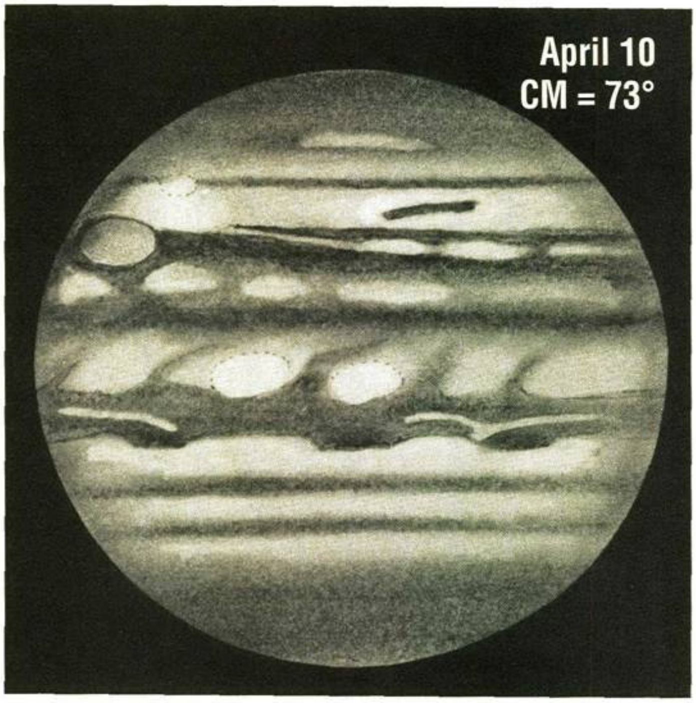
The Great Red Spot is without doubt the most famous feature on Jupiter. It's over one hundred years old and perhaps much older — the Italian-French astronomer Giovanni Cassini reported seeing a spot in 1665 that astronomers now think was the Red Spot. The spot is a huge anticyclone — a long-lived high-pressure bulge in Jupiter's southern hemisphere. Its reddish cloudtops, the coldest feature on Jupiter, rotate counter-clockwise in a period of six days. In July 1993 the spot appeared as a well-defined reddish ellipse about 20° long.

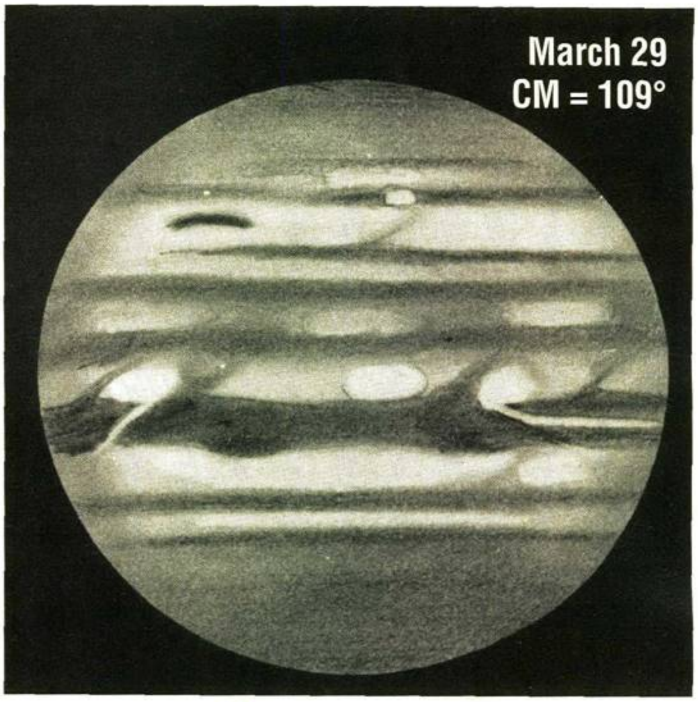
The Red Spot generally moves westward relative to the rest of the clouds, in the direction of increasing longitude, but its motion can be erratic. It sometimes moves forward or backward and drifts ahead or behind other features.

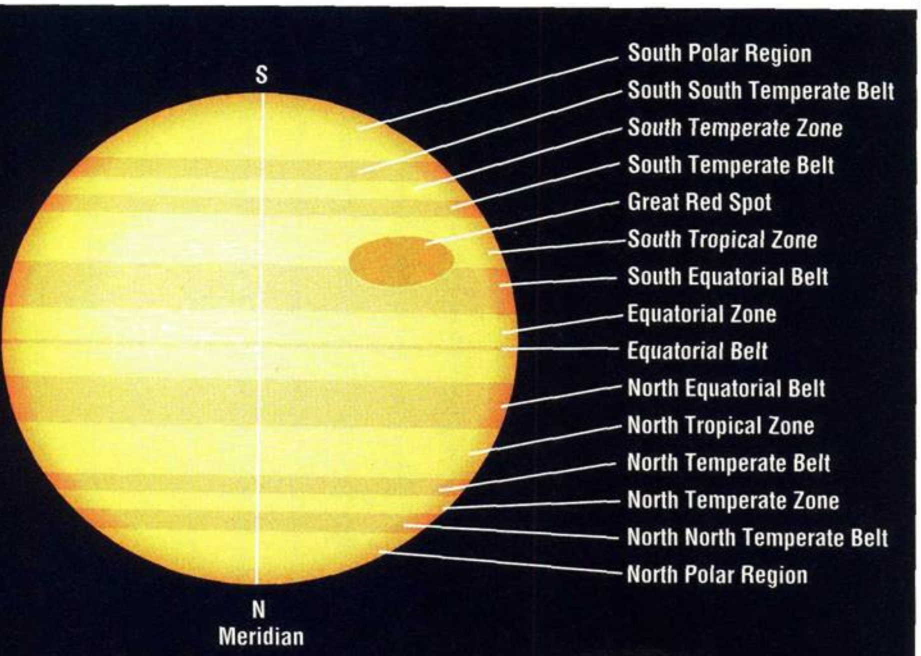
This makes it difficult to predict the precise longitude of the Red Spot in the months ahead. Last July the longitude of the center of the Great Red Spot lay at 48° in System II coordinates and was moving slowly in the direction of increasing longitude. (Because different regions on Jupiter rotate at different rates, astronomers break down Jovian latitudes into two systems. System II consists of all areas on Jupiter north of the southern edge

Jean Dragesco

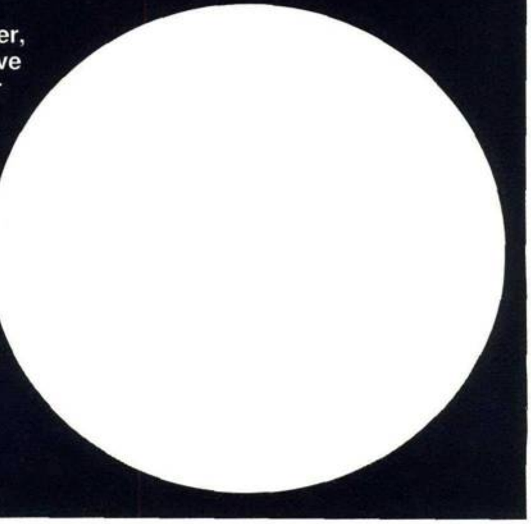
GIANT JUPITER DISPLAYS a wonderfully varied atmosphere in backyard telescopes. This spring offers the perfect chance to get to know the planet and to prepare for its collision with Comet Shoemaker-Levy 9 this July.


April 10
CM = 73°


March 29
CM = 109°


S
N
Meridian
South Polar Region
South South Temperate Belt
South Temperate Zone
South Temperate Belt
Great Red Spot
South Tropical Zone
South Equatorial Belt
Equatorial Zone
Equatorial Belt
North Equatorial Belt
North Tropical Zone
North Temperate Belt
North Temperate Zone
North North Temperate Belt
North Polar Region

WHAT'S IN A NAME? On Jupiter, quite a lot. Astronomers have developed a detailed scheme for naming the alternating series of bright zones and dark bands that form the major features visible in a telescope. The best way to become familiar with these and the smaller features often seen in the Jovian cloudtops is to sketch the planet as you view it in the eyepiece. You can photocopy the blank ellipse at right as a template for your sketches.

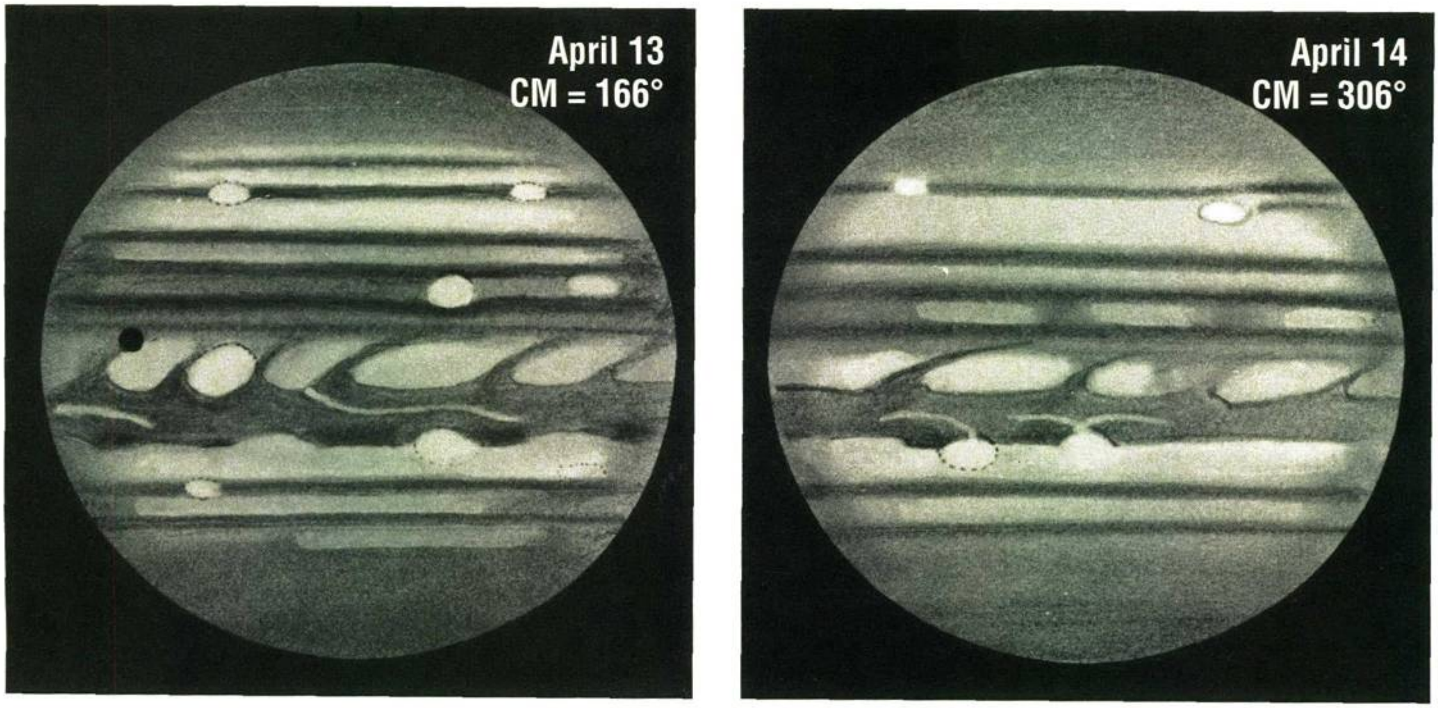


of the North Equatorial Belt and south of the northern edge of the South Equatorial Belt and rotates around Jupiter in 9 hours 56 minutes. System I applies to the equatorial regions, which rotate once every 9 hours 50 minutes.) See "Computing Mars and Jupiter" in the July 1993 issue for a computer program that calculates the transit times of the Great Red Spot. You can modify that program as described on page 78 to calculate the central meridian in System II coordinates on Jupiter at any time.

After the Great Red Spot, the second longest-lived features now seen on Jupiter are three white oval spots known as BC, DE, and FA. These small rotating cyclones were discovered in 1939 and have been seen ever since. In 1993 they were each about 8° long, and spot FA passed south of the Great Red Spot on August 1.

At a latitude of −30°, the white ovals belong to the South Temperate Belt. Because that belt is now quite prominent, the white ovals should be easy to pick out with a 6-inch or larger telescope. Get acquainted with them now, however, to avoid confusing them with any mimicking feature generated by July's comet impact.

Other activity observed in Jupiter's southern latitudes last year included a South Tropical Disturbance and an unusual Baby Red Spot. The South Tropical Disturbance developed in the South Tropical Zone, between the South Equatorial Belt and the South Temperate Belt, and extended from near the Great Red Spot to longitude 112° (in System II coordinates). It consisted of dusky patches of shading in the South Tropical Zone that devel-



Jean Dragesco

A STRIKINGLY COMPLEX North Equatorial Belt, featuring several festoons and rifts and a South Equatorial Belt consisting of two or three distinct components highlighted Jupiter in the early spring of 1991. All sketches show south at top and give the date and central meridian (in System II coordinates).

oped alongside the resurging South Equatorial Belt. In 1994 astronomers expect the preceding end of this disturbance, the eastern end that precedes the feature around Jupiter as the planet rotates, to have re-gathered on the preceding end of the Red Spot. Considering Jupiter's penchant for rapid change, however, this disturbance may or may not still be active.

The Baby Red Spot, as I mentioned, also attracted wide attention last year. It occupied the same latitude as the Great Red Spot in the South Tropical Zone and was observed from March through June at longitudes 329° to 336° (according to System II). Although much smaller than the Great Red Spot, the Baby Spot resembles it in shape and color.

HOW TO SEE FINE DETAIL

Because Jupiter is so active and presents such a large surface, it rewards almost any size telescope. But serious observers who seek fine detail traditionally prefer a well-collimated, large-aperture telescope with little or no central obstruction. Although you can observe a great deal on Jupiter with a 4-, 6-, or 8-inch aperture, for seeing very fine detail this year I recommend a 10-inch telescope. A good choice would be a 10-inch reflector with a small secondary mirror, which will help minimize diffraction and thus avoid undermining the already subtle contrast of Jupiter's finer features.

With a resolving power of better than one arcsecond and great light-gathering capability, a 10-inch scope will permit you to view both tiny features and their color during moments of excellent seeing. These advantages should make it possible to see tiny colored nodules or plumes that may develop when the comet fragments crash into Jupiter in July.

Eyepieces also play an important part in an ideal high-resolution planetary telescope. To get the greatest resolution your telescope and local seeing conditions permit, I recommend using orthoscopic or modified Plössl eyepieces that give powers in the range of 150x to 300x. Color filters will help enhance your views as well. To distinguish between the reddish and bluish clouds that are almost always present on Jupiter, use Wratten filters #38A (light blue) and #25 (red).

Seeing very fine detail on Jupiter also requires a trained, discerning eye. If you have not paid much attention to the finer features on Jupiter up to now, you need to get in practice. To a novice, Jupiter often looks like a bland disk crossed by two or three dusky bands. But as observers become more experienced, they also see many fine dark and white features on the disk, some of which even appear brown, orange, and blue. Because Jupiter does not reveal its finer cloud features easily, you must train your eye to see them.

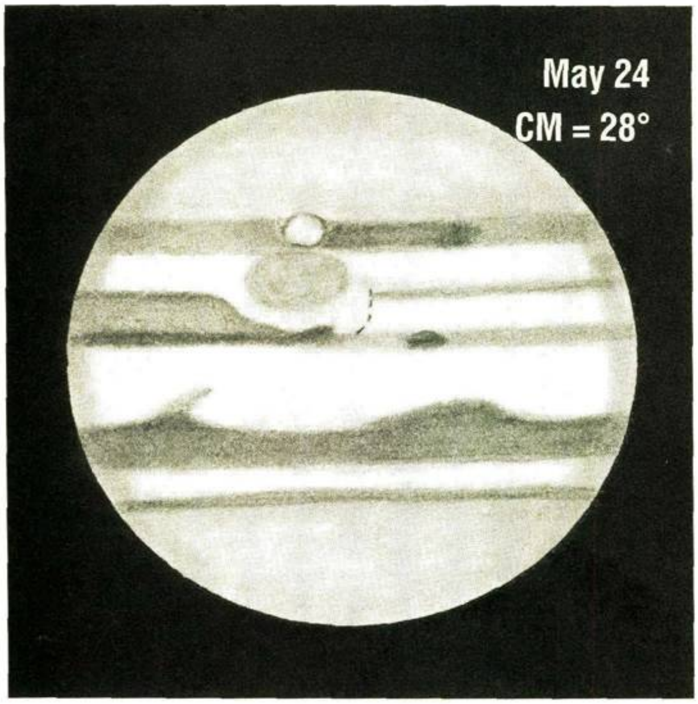
You can begin sharpening your skills by concentrating on the belts and waiting for moments when the atmosphere steadies and the image sharpens. Look for detail at the edges of the belts, where features tend to stand out because of their high contrast. In the North Equatorial Belt, look for rifts and dark or white spots that may appear in the belt's center or at the edges. Can you discern the white oval spots in the South Temperate Belt? Can you see the graceful festoons in the Equatorial Zone? As you gain visual observing experience, Jupiter's finer features will become apparent. It doesn't take too much. Even after a few nights of systematic observing, you'll start noticing details you didn't catch at first. And you'll just get better as you keep at it.

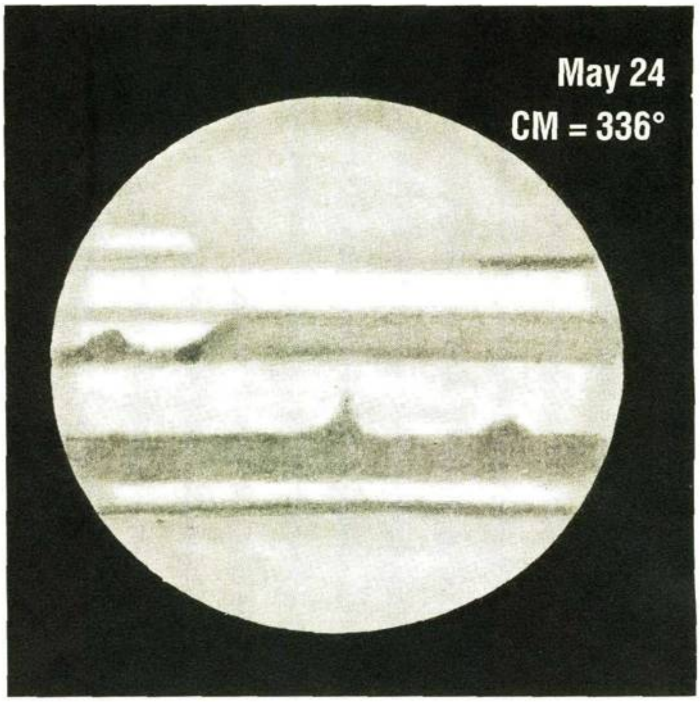
AN ABUNDANCE OF FEATURES

The chart at left shows the names and locations of all the belts and zones on Jupiter. But the smooth regularity is an oversimplification of what you can see through a moderately large telescope. That's because at times of good seeing, the belts appear to break up into dark and bright features that last only as long as the seeing holds. Six specific types of active and intrusive little clouds occur often enough that they have their own names:

Projection — A dark protuberance on the edge of a belt. Common on the south edge of the North Equatorial Belt.

Festoon — A dusky filament





looping out into a zone from the edge of a belt. Frequently seen in the Equatorial Zone.

Oval — A white, round or oval area that is fairly bright and well-defined. Common on the south edge of the North Equatorial Belt.

Rod or *Bar* — A very elongated dark condensation with its major axis parallel to an adjacent belt.

Nodule — A small bright spot, usually round and not much larger than the disk of Ganymede, Jupiter's largest satellite. Often seen in the south polar region near the latitude of the South South Temperate Belt.

Rift — A long, bright streak extending horizontally along the interior of a belt. Common in both the North and South Equatorial Belts.

WHAT WILL THE COMET ADD?

The train of 21 nuclei of Comet Shoemaker-Levy 9 should strike Jupiter just south of the South Temperate Zone. What temporary new features can we expect in this region from the comet impacts? Will they emulate any existing Jovian features?

Reta Beebe of New Mexico State University in Las Cruces points out that if the comet fragments penetrate deep enough into the South Temperate Zone, water vapor may shoot high into the atmosphere where it could turn into a bluish shroud over a portion of the zone. If something like that happens, it would be the most readily visible event in small backyard telescopes.

Impacts of the largest fragments may create one or two other features. First, a spot might develop. It could be a white or dark blue nodule and would likely have a maximum diameter of 2,000 to 2,500 km, which in your telescope would be 1" to 1.5" across. The nodule would be very short-lived, with the impact site probably returning to normal after just a few rotations of Jupiter.

Second, a dust plume might also develop. It would look dark against the South Temperate Zone's white

COMPUTING JUPITER'S CENTRAL MERIDIAN

Jupiter spins faster than any other planet in the solar system. It rotates so rapidly, in fact, that your view of it in a telescope changes noticeably in as little as ten minutes.

One way to figure out what part of Jupiter you are looking at is to calculate the planet's central meridian — the longitude that bisects the planet from north to south. A few quick and easy modifications to the JUPITER.BAS computer program that appeared last year in ASTRONOMY (see "Computing Mars and Jupiter," July 1993) will make it print out the central meridian of Jupiter instead of the transit times of the Great Red Spot.

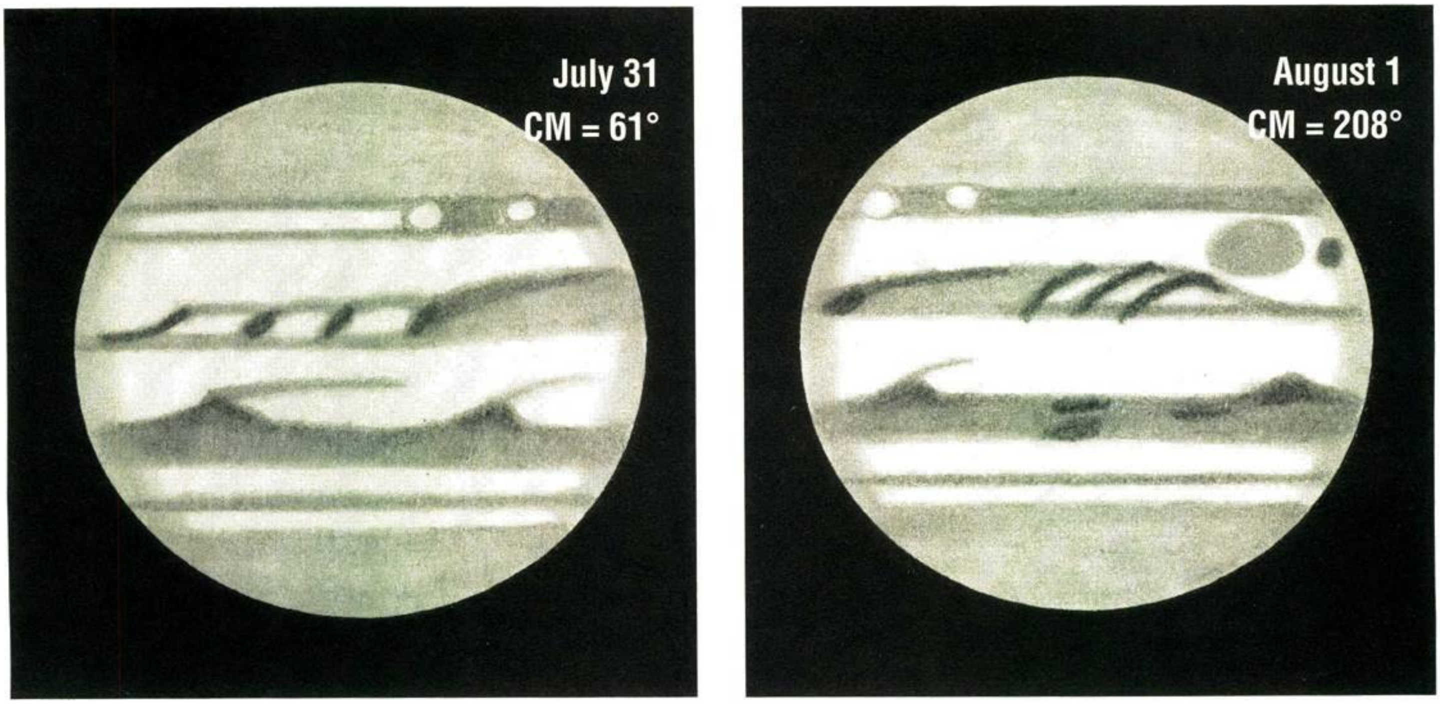
The first change allows you to enter the exact hour you plan to observe. Rewrite line 80 and then add lines 83 and 87 so that part of the program reads:

```
80 INPUT "Enter the day ";DAY
83 INPUT "Enter the hour (in 24-hour mode) ";HOUR
87 DAY=DAY+(HOUR+ZONE)/24+1/1440
```

Next you need to modify the section beginning at line 800 so it calculates the central meridian at the hour you specify instead of at midnight. Simply add the following three lines after line 900:

```
910 IF MER<0 THEN MER=MER+360
920 PRINT:PRINT:PRINT"The central meridian on Jupiter is ";USING"####";MER
930 END
```

Finally, DELETE lines 1000 to 1100. After you're done, SAVE the file with a different name so you don't overwrite JUPITER.BAS. You will then have a program that will tell you the central meridian on Jupiter accurate to within 1°.



José Olivarez

FAINTER THAN NORMAL at the beginning of 1993, the South Equatorial Belt grew stronger in April and May and was back to full strength by late summer. An event of particular note occurred in late July and early August, when the white oval FA passed directly south of the Great Red Spot.

clouds or could appear as a bright jet projecting from Jupiter's limb. Imagine how awesome it would be to watch such a plume rotate into view several minutes after the impact of a comet fragment.

SKETCHING JUPITER

Seeing the effects created when a fragment hits Jupiter is one thing, but recording that detail for future use is something else. If you want to photograph Jupiter while the effects are still visible, see "High Impact Astrophotography" on page 64. Though photos are great, sketches can often be more useful — they can render fine cloud detail that frequently gets blurred when seeing conditions change during a time-exposure photograph.

By convention, observers draw full-disk sketches of Jupiter on elliptical disks that are 2.5 inches in equatorial diameter. Either photocopy the template shown on page 76 or buy a 70° ellipse template in an art-supply store. Draw the disk on paper that is comparatively smooth and as white as possible. Standard office-supply bond paper works well.

Ordinary pencils such as #2s are not ideal for sketching Jupiter because it's hard to vary the shading. Drafting pencils, also found at art-supply stores, work better. The soft grades (2B to 6B) are best for sketching planetary surfaces. These produce an even tone and constant texture, which you can vary by changing the pressure on the paper. Also buy a kneaded rubber eraser so you can make fine erasures.

MAKING THE SKETCH

When sketching Jupiter's full disk, work quickly. The planet's rotation shifts cloud features a full 3° in just five minutes. The motion is from right to left in a normally inverted telescopic view having south at top. (With most instruments, however, using a star diagonal reverses the image, which can make the drawing more difficult to interpret.)

As you begin to sketch, first lightly pencil in the major dark belts in their correct thickness and indicate their order of intensity. Be sure to place the belts correctly so that they parallel each other and Jupiter's equator. Next, work rapidly to place the finer details in the belts and zones. At the beginning of this step, record the time to the nearest minute and don't spend more than five minutes adding details. This will minimize your misplacing features due to rotation. As you sketch the fine details, constantly recheck their position in relation to other prominent features to ensure the placement is accurate. Use the kneaded eraser to create light areas in the belts.

Finally, check the placement of details and finish the sketch by shading the belts and other features to their respective intensities. Then use an artist's stump (a sticklike device used to smoothen tones) to make the features appear more natural.

To complete the sketch, note the date and time of your observation, the aperture and type of telescope you used, the magnification, and the atmospheric conditions. Judge the seeing conditions on a scale of 1 to 10. (If the seeing is 1, the image is hopelessly blurred; if the seeing is 10, the image is perfectly steady.)

Also consider submitting reports of your observations of Jovian weather before, during, and after the comet crash to ALPO Jupiter Recorders, 1469 Valleyview Court, Wichita, Kansas 67212. They will be helping astronomers monitor the impacts and their effects on Jupiter. Specific reports of comet crash phenomena should be sent to Phillip W. Budine, ALPO Comet Encounter Coordinator, R. D. 3, Box 145C, Walton, NY 13856.

Feel free to send drawings, photos, CCD images, or descriptive reports. Even if you don't see any effects caused by the comet impacts, that information is valuable. After all, the goal is to see what the impacts do to Jupiter, and if that is nothing, then astronomers will have learned something important about this gas giant. ☐

José Olivarez has been observing Jupiter since 1960 and is Jupiter recorder for the Association of Lunar and Planetary Observers. He is also the director of the Omnisphere and Science Center in Wichita, Kansas.

Hats, Hockey Sticks, & Humpbacks

by
Kenneth Hewitt-White

Come along on a journey to the spring sky's edge-on galaxies and see what's in a name.

M82 in Ursa Major

Mag. 8.4
Size 11.2' by 4.6'
by Jack Newton

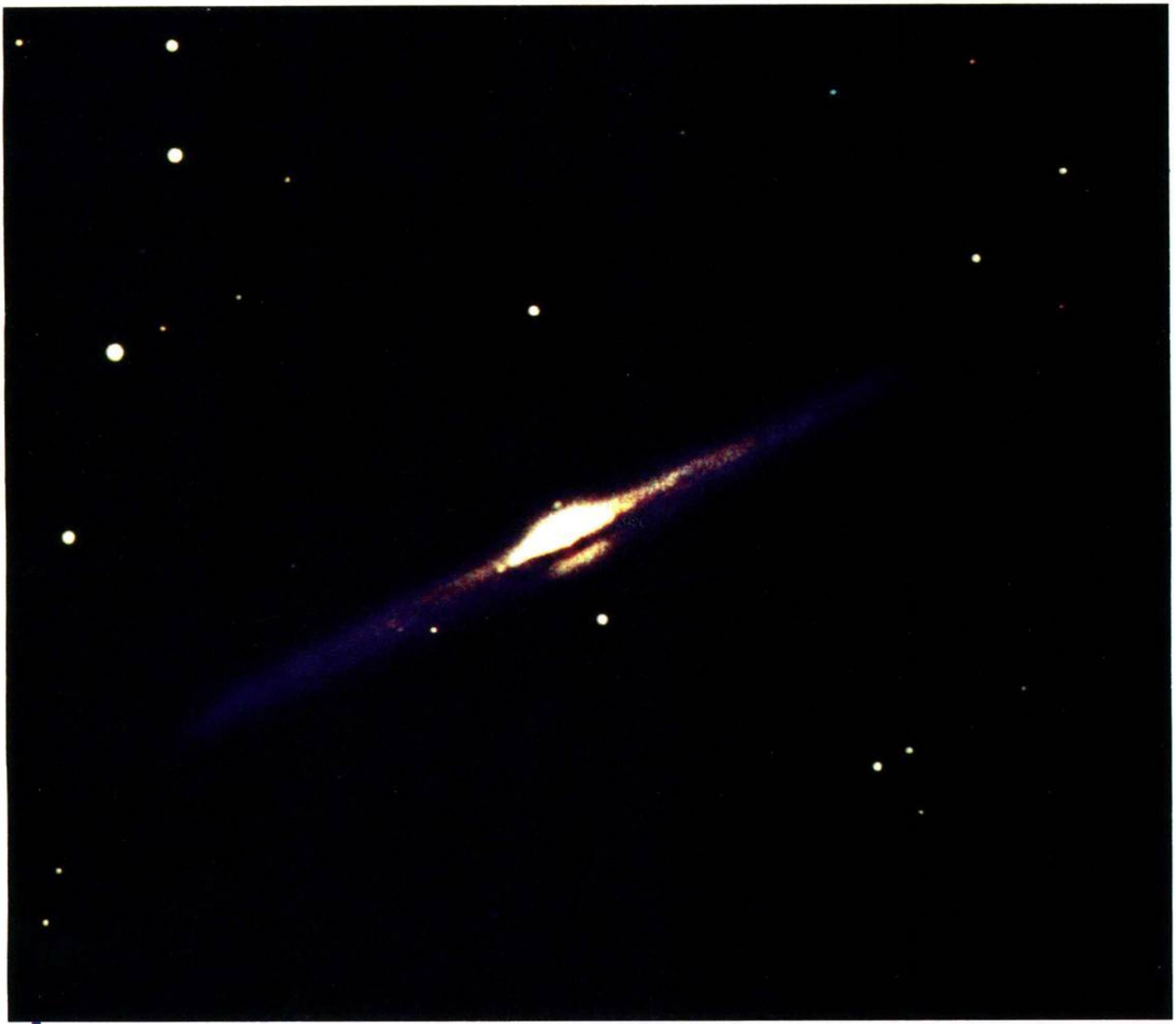
Everyone knows their names — the Whirlpool, the Helix, the Dumbbell, the Lagoon. It seems that every bright deep-sky object has a nickname. And these well-named objects are well observed on dark, starry nights. Backyard astronomers now have the ability to explore these objects in enough detail to see the features that gave rise to the names. Aim a large reflector at the Lagoon Nebula, for example, and you'll see the dark lane that forms a celestial lagoon between islands of glowing gas.

We see such features in these deep-sky objects because they are oriented to our advantage. We see the beautiful spiral structure of the Whirlpool Galaxy because its spiral arms face us, providing a view reminiscent of the last ounces of water spiraling into a bathroom drain. But most galaxies are not positioned so advantageously, and we see them at all manner of angles.

The least revealing of these galaxies must be the edge-on spirals. The disks of these galaxies happen to lie along our line of sight so that we view only their edges. It's like seeing the side of a dinner plate sitting atop a table at eye level. How could you possibly see any detail on the plate? How can we possibly see enough detail in these edge-on galaxies to give them proper nicknames? Suspend your suspicion about these objects by viewing several in your scope and you'll be surprised by the graceful forms and features of a group of galaxies I like to call the hats, hockey sticks, and humpbacks.

First let's talk hats. Probably the best known of the spring edge-ons, the **Sombrero Galaxy** (M104, NGC 4594), lies in Virgo near that constellation's border with Corvus. It's easy to locate in your finder scope by aiming $3^{1}/_{2}°$ south of Chi (χ) Virginis. Because it glows brightly at magnitude 8, the Sombrero can be glimpsed in large finders. Many backyard observers know about this colorfully named galaxy, so it's a good place to start our tour.

The Sombrero resembles a sombrero only because of its alignment to our line of sight, which is close to, but not quite, edge-on. And it has earned this nickname more for its visual than photographic appearance. On photos we often see an overexposed elliptical core cut in half by a broad dust lane. No hat



NGC 4565 in Coma Berenices

Mag. 9.6

Size 16.2' by 2.8'

by Bill and Sally Fletcher

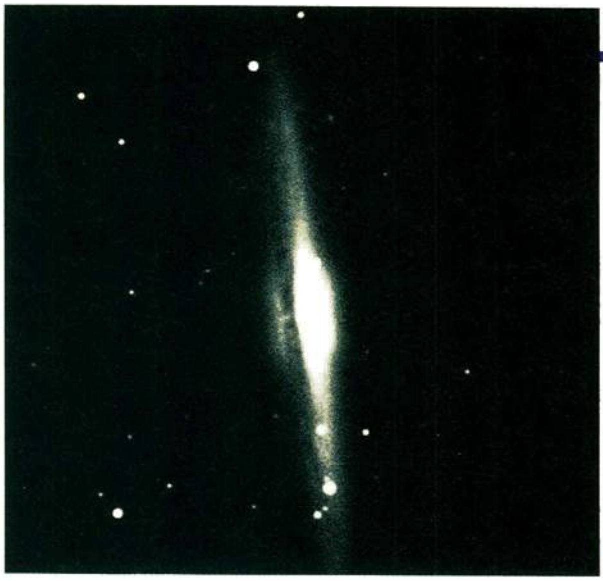
here. But try observing M104 carefully at high power in your telescope. A large elliptical core surrounds a pinpoint nucleus that appears a little north of center, while its signature dust lane cuts right across the galaxy, south of its center. Depending on the size of your scope and the sky darkness, the south portion of the core may not be visible at all. The resulting hard edge produces the appearance of the base of a wide-brimmed Mexican hat.

In my 10-inch Dobsonian, the Sombrero measures a compact 6' by 2'. It appears about a third larger in a 17.5-inch scope. Like many edge-on galaxies, M104 is a high-contrast subject, and it bears magnification well in any telescope. Perceiving the thick, black dust lane gets easier as you increase magnification.

NGC 4565 in Coma Berenices defines the classic edge-on galaxy. I call it the spindle. If you're a first-time galaxy hunter, this treat awaits you just 2° east of 17 Comae Berenices. The object glows at 10th magnitude and is nearly a third of a degree long. NGC 4565 is another fine example of a hat, showing a classic edge-on spindle with a thin brim.

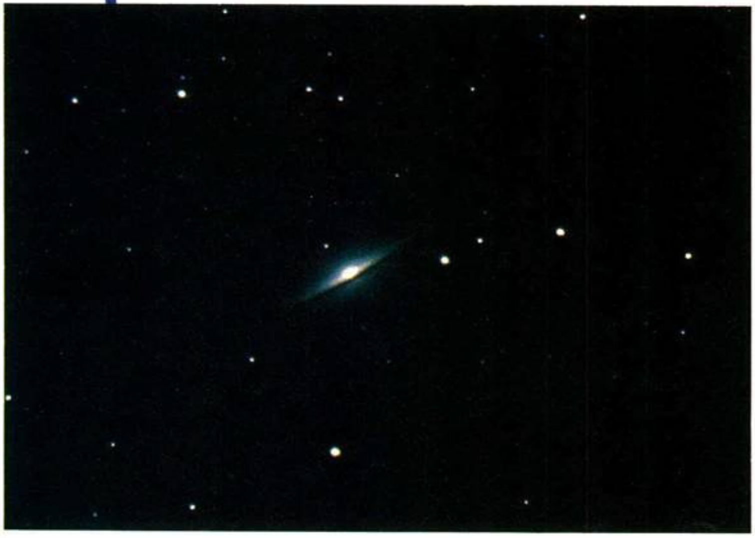
Even this "perfect" edge-on is turned ever so slightly toward us, as a good photo confirms. In my 10-inch scope at 160x the slim shape of NGC 4565 stretches more than halfway across the field. A pencil-thin dust lane bisects the galaxy. The elliptical nucleus shines most brightly southwest of the dust lane, while a tiny, much dimmer portion, next to a foreground star, glows northeast of the lane.

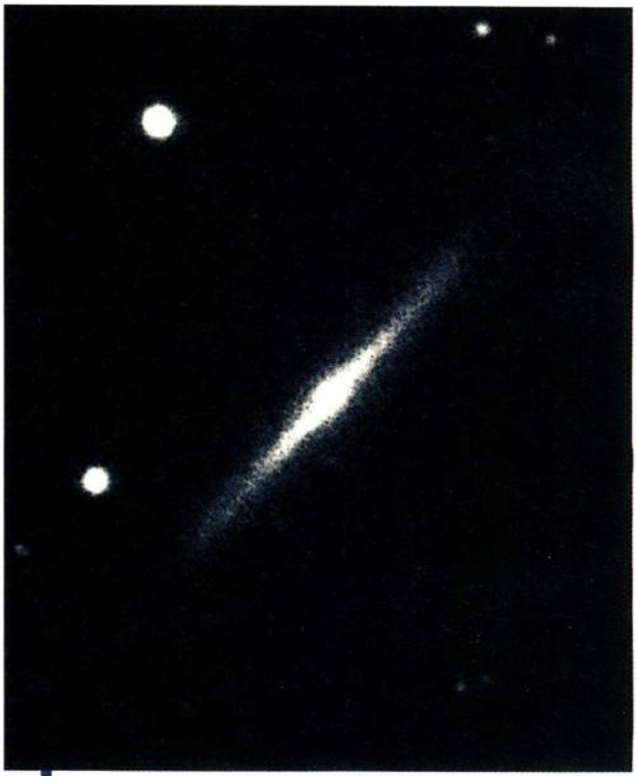
I like the spindle so much that I keep an eye out for other galaxies that are miniature versions of it. Virgo contains two bright examples, and as luck would have it, they're easy to find.



NGC 5746 in Virgo
Mag. 10.6
Size 7.9' by 1.7'
by Kim Zussman

The Sombrero Galaxy (M104)
Mag. 8.3
Size 8.9' by 4.1'
by Jack Newton





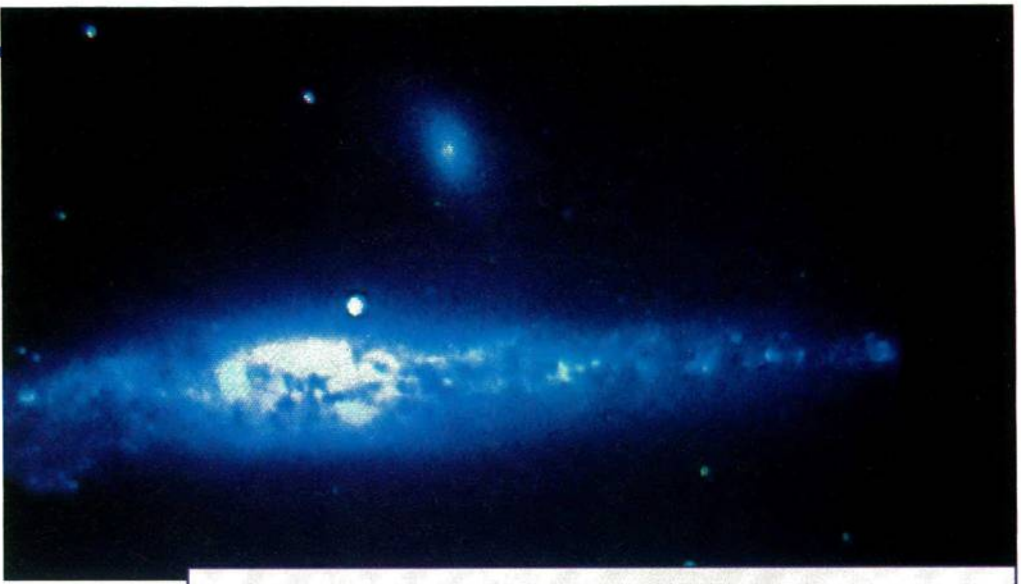
NGC 4762 in Virgo
Mag. 10.2
Size 8.7' by 1.6'
by Preston S. Justis

The first is 10th-magnitude hat-shaped **NGC 4762**, easily found about 2° west and slightly north of 3rd-magnitude Epsilon (ε) Virginis. This galaxy is like NGC 4565 in almost every respect. With a length of almost 9', it's a little over half the size of NGC 4565, but it exhibits the same characteristically small, bright core with arms that thin out to needle like ends on either side. I call it the mini spindle.

In a 17.5-inch scope at 220x, the mini spindle appears sharp and distinct, with possibly a clipped edge along one side, as we see with the Sombrero. This would imply the galaxy isn't exactly edge-on. Three bright field stars that nicely frame this galaxy are visible in any scope.

Only 10' northwest of NGC 4762 you'll find another hat-shaped galaxy, **NGC 4754**, a smaller spiral system seen almost face on. It's only a little fainter than its edge-on neighbor, and sports a nearly round figure somewhat larger than the central region of NGC 4762. The combination makes a picturesque catch in almost any telescope. A 10-inch scope gives a pleasing view of these two, especially at higher powers.

Another NGC 4565 look-alike lies in eastern Virgo, about 20' west of the 4th-magnitude star 109 Virginis. **NGC 5746** shows a large, bright core and an overall appearance more diffuse and less contrasty than that of NGC 4762. At magnitude 10.6, the hat-shaped galaxy is an obvious target, but the galaxy's relatively low surface brightness makes it more challenging. Don't get supernova anxiety when you haul in NGC 5746. The faint star seemingly buried inside the south end of the galaxy is a foreground star in the Milky Way.



NGC 4631 in Canes Venatici

Mag. 9.2

Size 15.1' by 3.3'

by Jack Newton

SPRINGTIME EDGE-ON GALAXIES

Object	R.A. (2000.0)	Dec.	Mag.	Size
M82 (NGC 3034)	09h55.8m	+69°41'	8.4	11.2' by 4.6'
NGC 4565	12h36.4m	+26°00'	9.6	16.2' by 2.8'
M104 (NGC 4594)	12h40.0m	−11°37'	8.3	8.9' by 4.1'
NGC 4627	12h42.0m	+32°35'	12.3	2.7' by 2.0'
NGC 4631	12h42.1m	+32°33'	9.2	15.1' by 3.3'
NGC 4754	12h52.3m	+11°19'	10.6	4.7' by 2.6'
NGC 4762	12h52.9m	+11°14'	10.2	8.7' by 1.6'
NGC 5738	14h43.9m	+1°36'	14	1.4' by 0.4'
NGC 5740	14h44.4m	+1°40'	11.9	3.1' by 1.7'
NGC 5746	14h44.9m	+1°57'	10.6	7.9' by 1.7'

Like NGC 4762, NGC 5746 offers a bonus of companion galaxies in the same field. **NGC 5738** and **NGC 5740**, glowing at respective magnitudes of 14 and 12, are tiny elliptical patches — not edge-on hats. Diminutive and dim, they require clear, dark skies.

Up to now, we've tracked down ordinary spiral galaxies. Other edge-on galaxies are irregulars. Find **M82** (NGC 3034) in Ursa Major by extending a line diagonally across the bowl of the Big Dipper, from Gamma through Alpha, to 5th-magnitude 24 Ursae Majoris. A couple of degrees east lies cigar-shaped M82.

The cigar has nearly everything a galaxy-lover could want: lots of brightness (magnitude 8.4), large size (11' by 4.6'), high contrast, and an intriguing structure that defies explanation. M82 exhibits a mottled surface in almost any scope at high power. In a 17.5-inch scope at 220x, the central region clearly breaks up into several light patches and at least two dark, irregular lanes. It seems this celestial cigar is smoking from the middle.

You'll find an odd pair of galaxies in Canes Venatici, 20° south of the bowl of the Big Dipper. A friend of mine called 9th-magnitude **NGC 4631** the "Humpback Whale" the moment she saw it. Even a 10-inch scope reveals an asymmetry that suggests the form she saw. One especially dark night last May, I cranked up a 17.5-inch scope to 450x and tape-recorded my impressions of this smudgy cetacean. The transcripts describe a big, fat, edge-on system that lacks the spindly character of the NGC 4565 look-alikes and shows no sign of a dust lane. It's long and tapered at one end and stubby at the other.

A 12th magnitude star nearly touches the edge of NGC 4631's underbelly. **NGC 4627**, a calf at bay next to the Humpback, lies near this star. Compared with NGC 4631, this little fellow seems even smaller than its modest 2.7' by 2.0' size indicates. It glows at 12th magnitude, making averted vision necessary if I wish to detect it with a 10-inch scope.

Only half a degree southeast you'll find a smaller and fainter target that sports two NGC numbers whose visual appearance suggests two separate objects. But it is, in fact, a single galaxy. Confused? **NGC 4656** and **NGC 4657** were so labeled because they look like interacting galaxies. In reality, it is a single irregular system.

At first glance, it resembles a lopsided letter "V." At high power it reminds me of the shaft and blade of a hockey stick. Using a 17.5-inch scope, I can almost convince myself that I see a slender galaxy (NGC 4656) with only one of its spiral arms (NGC 4657) swinging away to the side. However, I can't ignore the impression of seeing two galaxies. NGC 4656 tapers down to the point where NGC 4657 joins it on a shallow angle, giving the erroneous idea of two galaxies in contact.

Unusual features appear in the shaft of the stick. At low power, the 17.5-inch scope shows the side east of NGC 4656's core, but nothing west of it — as though only half a galaxy exists. Higher power reveals a tenuous, tapered portion at the "missing" end. I find it similar to a comet's tail, and the effect is enhanced with averted vision.

By nickname or number, I know you'll enjoy tracking down these fine edge-on galaxies. They exhibit gratifying detail in 10-inch or 12-inch telescopes, and those with larger apertures will turn to the galaxies again and again to pry out subtle features. The hats, hockey sticks, and humpbacks may even inspire you to come up with a few names of your own. □

Kenneth Hewitt-White has been observing the deep sky for 26 years. A former planetarium educator and producer, he now enjoys teaching and writing in British Columbia's dry Okanagan Valley.

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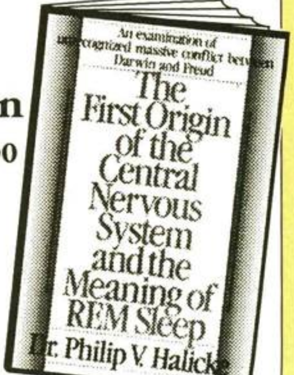
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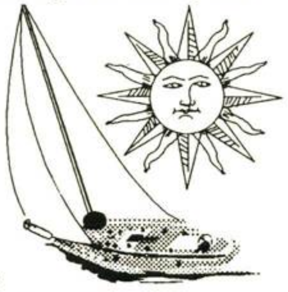

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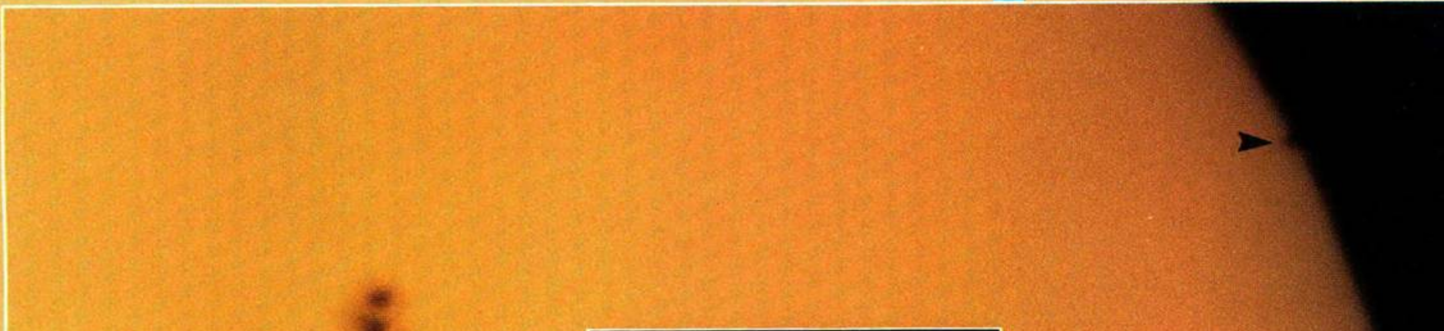
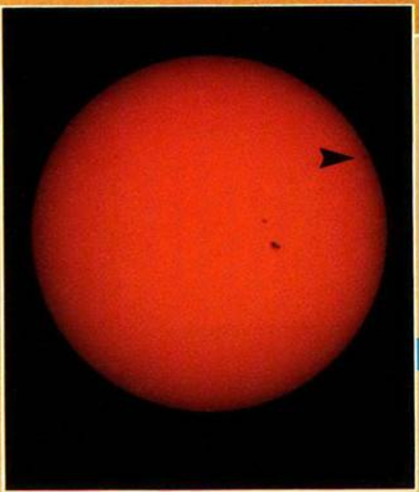
READER REPORTS

Mercury's Transit from Down Under

The Transit of Mercury (Mercury arrowed)

by Ernie Piini
(90mm Maksutov-Cassegrain, Kodacolor 200 film, 1/250-second exposure with ND-4 solar filter on November 6, 1993, from Canberra, Australia)





The Transit of Mercury (Mercury arrowed)

by James Kevin Ty
(80mm Maksutov-Cassegrain, Velvia 50 film, 1/1000-second exposure with an ND-4 solar filter on November 6, 1993, from Manila, Philippines)

On November 6, 1993, tiny Mercury transited the face of the Sun for the twelfth time this century. The transit was visible in its entirety from India, Southeast Asia, China, Japan, Indonesia, Australia, and New Zealand. Mercury's disk measured a mere 10" across, only 1/194th the diameter of the Sun. In fact Mercury's transit was very nearly a graze, as the planet took 101 minutes to cross a small segment of the Sun's southwestern limb.

California astrophotographers Ernie Piini and Joe Shrock decided months before the transit they would travel to see and photograph it. The two decided on a journey to Australia, and before they had booked their flights they began constructing a heliostat. By using a small motorized flat mirror to reflect light into a camera, the Californians sidestepped a hefty mounting and problems with recording a steady image.

"By using a state-of-the-art camcorder we could make timings of the four contacts that were precise to within a second," says Piini. The photographers set up near Canberra at a campsite, making good use of a volleyball court and nearby picnic tables as a base of operations. Sounds of Australian wildlife — kangaroos, kurawangs, rosellas, cockatoos, and cottontail rabbits — resonated through the surrounding air. The wind kicked up during the transit but did not prevent the explorers from coming home with a stockpile of images.

Observing Faint Nebulae. On the afternoon of October 16, 1993, the floor of his family room sat half an inch below a layer of astronomy books and atlases. Had he been burglarized? No. Randy Pakan of Edmonton, Alberta, was simply gearing up to observe faint nebulae. Like any good deep-sky observer, he was doing detailed homework before heading under the stars. "The nebulae I like to view force you to use a 16-inch Newtonian, various nebula filters, a dark cloth to drape over your head, and averted vision," says Pakan. "They aren't for the faint of heart."

On that evening Pakan and observing friend Alister Ling tackled Sharpless 2-157 in Cepheus and several faint objects surrounding it, including NGC 7538, the Bubble Nebula (NGC 7635), and Sharpless 2-157a. "We spent an hour on this area and then explored Sharpless 2-132," says Pakan. "We recommend this area to deep-sky observers who want to explore off the beaten path."

Improving Images by Camcorder. One limiting factor of planetary astrophotography is the relatively long exposure times involved. These make it difficult to expose conventional film quickly during moments of good seeing. CCD cameras help with that dilemma, but their cost makes them prohibitive for many backyard skyshooters.

David E. Thomas of Lynchburg, Virginia, suggests an easier and more affordable method for anyone who owns a camcorder. "I've taken videos of the Moon, selected sharp frames as I preview the tape on my television, and photographed the screen to produce pleasing, colorful slides of the Moon and planets," says Thomas. Inspecting the tape frame by frame allows you to choose the best images. To enjoy the result, see the photo of an old, unnamed crater that surrounds the Straight Wall, Rupes Recta, on the Moon (page 82). ☐

ASTRONOMY wants to hear about your observations of the sky. Send reports, photographs, and sketches to David J. Eicher, Reader Reports Editor, ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Please label each submission with name, address, and social security number.

Galaxy WLM in Cetus

by James R. Foster
(11-inch SCT at f/6.3, hypersensitized Tech Pan film, 95-minute exposure)

The Large Magellanic Cloud

by Luke Dodd
(4.7-inch f/8.5 refractor, hypersensitized Fuji 400 film, 60-minute exposure)

Omega Centauri

by Andrew Peters
(20-inch f/5 reflector, hypersensitized Fuji 400 film, 13-minute exposure)

The Rosette Nebula

by Brad D. Wallis and Robert W. Provin
(4-inch f/8 refractor, hypersensitized Tech Pan film, 120-minute exposure)

The Lagoon and Trifid Nebulae

by George Greaney
(6-inch f/7.1 refractor, hypersensitized Fuji Super HG 400 film, composite of two 30-minute exposures printed onto Vericolor film)

The Eclipsed Moon in Taurus

by Bob Yen
(165mm lens, Pentax 6x7 camera, Ektachrome 400 film, 16-minute exposure on November 28, 1993, from Anza-Borrego State Park, California)

Comet Mueller (1993a)

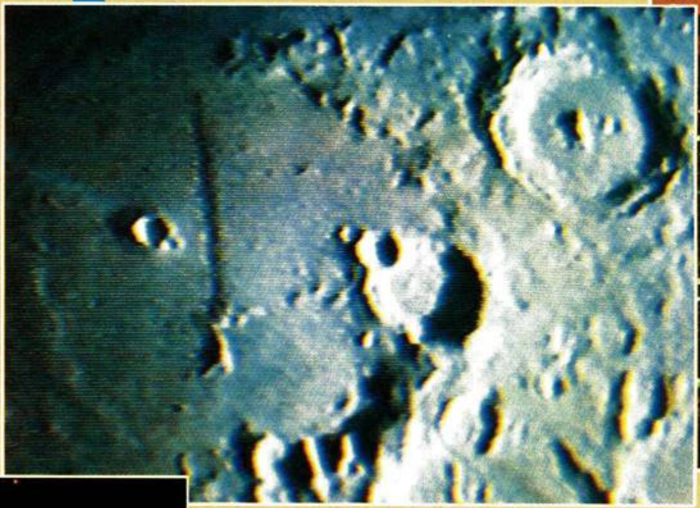
by Chris Cook
(8-inch SCT at f/6, ScotchChrome 400 film pushed to ISO 800, 30-minute exposure on November 13, 1993)

PLANETS GATHER IN THE MORNING SKY

Many planetary gatherings took place in 1993, offering astrophotographers chances to capture several planets together at once. On November 18, 1993, Jupiter, Mercury, and Venus (nearest the horizon) formed a line in the early morning sky, and bright star Spica (top) added a sparkling point of light. George Livadaras' photo of the gathering over Montreal (opposite page) wins this month's $100 "Best Astrophoto" award.

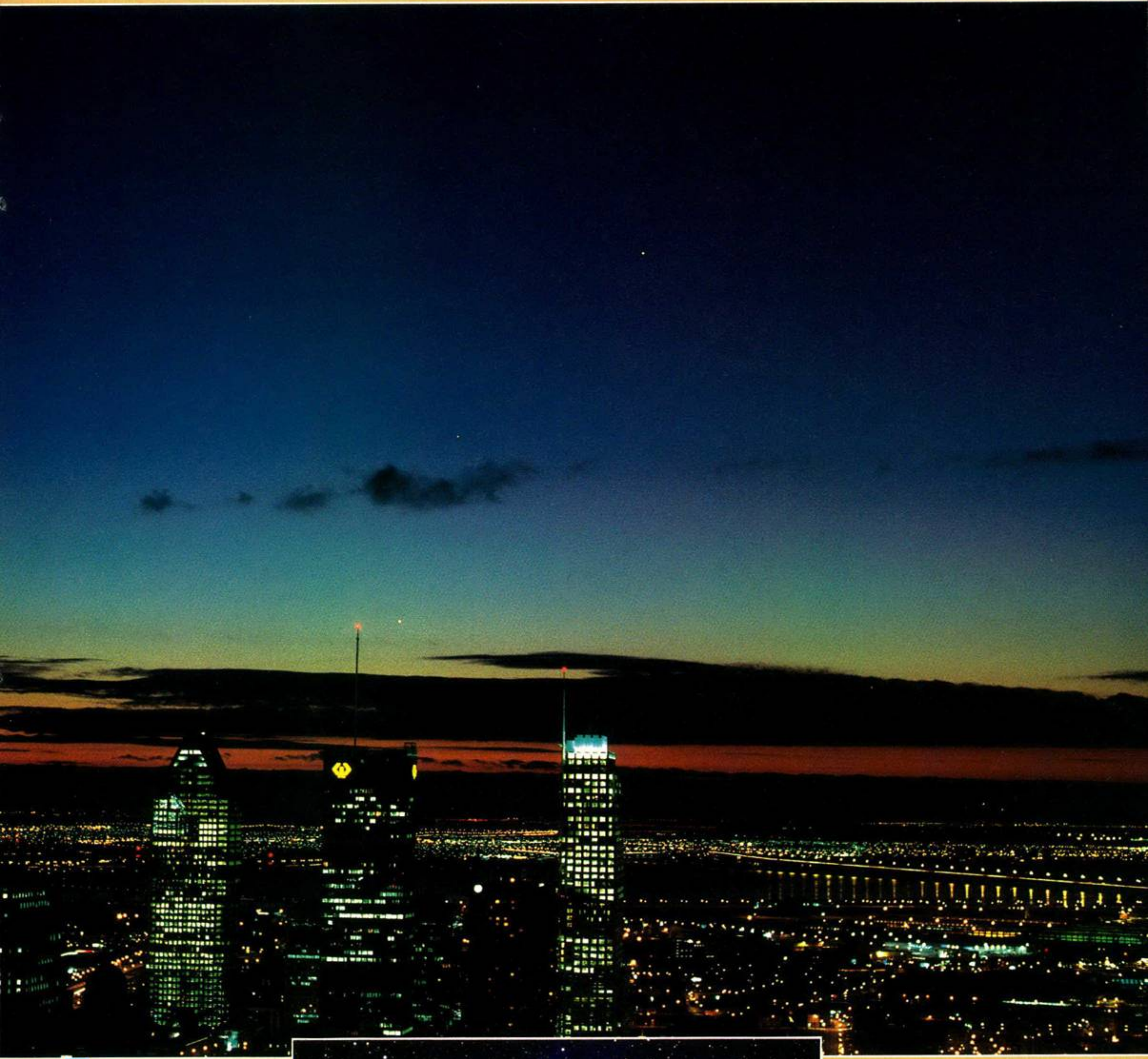
An Unnamed Lunar Crater and the Straight Wall

by David E. Thomas
(video camcorder image rephotographed onto slide film)



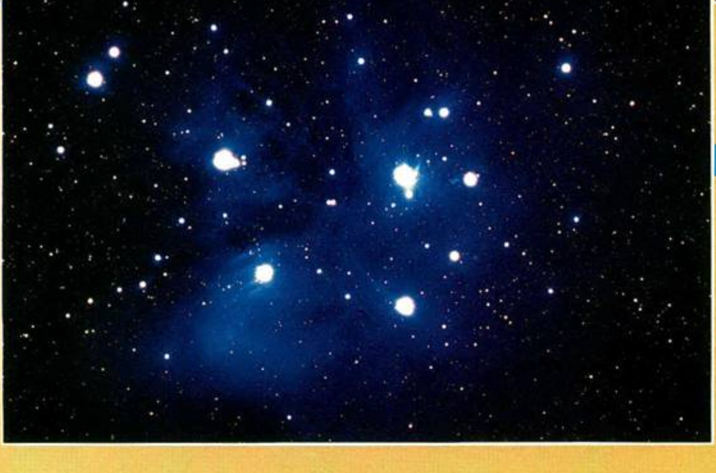
Spiral Galaxy NGC 45

by James R. Foster and Michael A. Stecker
(14-inch SCT at f/7, tricolor composite of three filtered exposures on hypersensitized Tech Pan film: 180-minute exposure with Wratten #25 red filter, 95-minute exposure with Wratten #11 yellow-green filter, and 222-minute exposure with Wratten #47A blue filter)



November's Planetary Conjunction

by George Livadaras (55mm lens at f/2.8, Kodachrome 64 film, taken on November 18,1993)



The Pleiades

by George Greaney (6-inch f/7.1 EDF refractor, composite of two 60-minute exposures on hypersensitized Fuji Super HG 400 film printed onto Vericolor print film)

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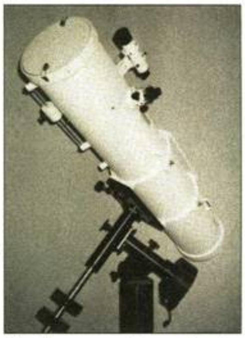

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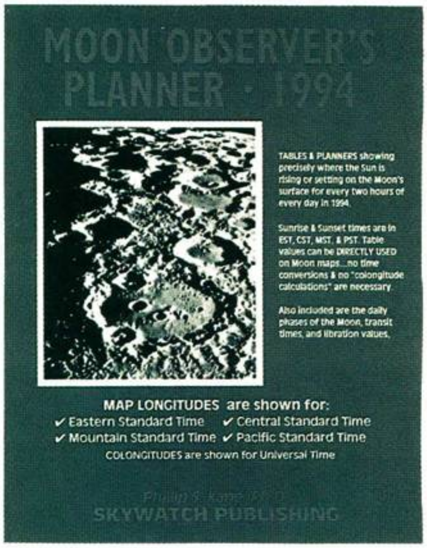
Skywatch Publishing, P.O. Box 920, Fillmore, CA 93016, (805) 524-6913. $9.95.



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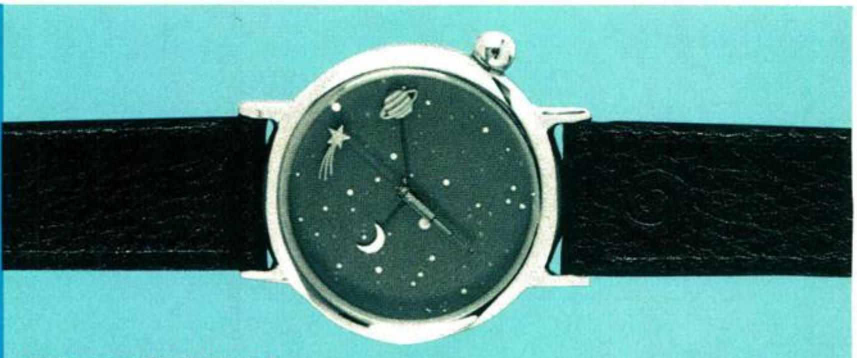

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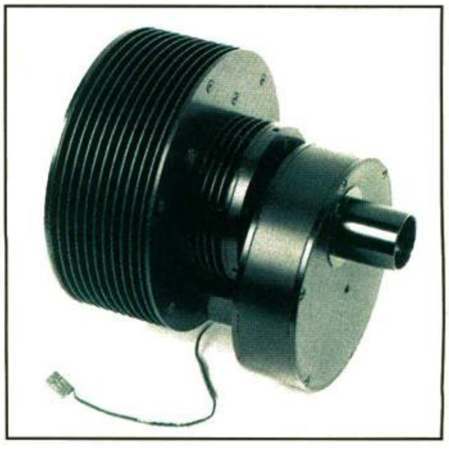

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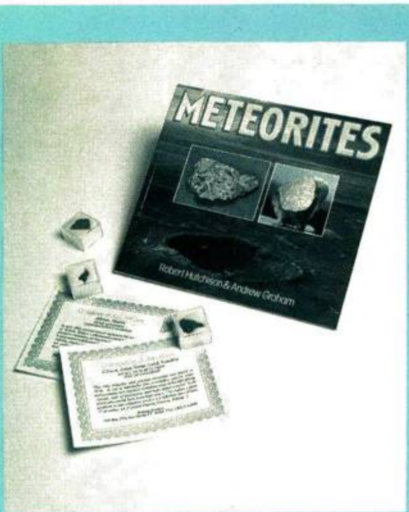
Bethany Sciences, P. O. Box 3726, New Haven, CT 06525, (203) 393-3395. $49.95 plus $6 shipping ($12 foreign shipments). A catalog of Bethany Sciences' line of meteorites is available for $2 ($5 foreign).



New Astronomy Posters

Hansen Planetarium's "Two Faces of Mars" color poster (shown) features mosaic images from the Viking orbiter prepared by the U.S. Geological Survey. Also available: "The Gas Giants," a color montage of four Voyager images of Jupiter, Saturn, Uranus, and Neptune, and "North America at Night" showing city lights and aurora from space.

Hansen Planetarium Publications, 1845 South 300 West, #A, Salt Lake City, UT 84115-1804, (801) 483-5400, fax (801) 483-5484. Two Faces of Mars and Gas Giants: $5.50 (paper), $11.50 (plastic laminated); North America at Night: $6.50 (paper), $14.50 (plastic laminated). Free catalog of other posters and slide sets available.

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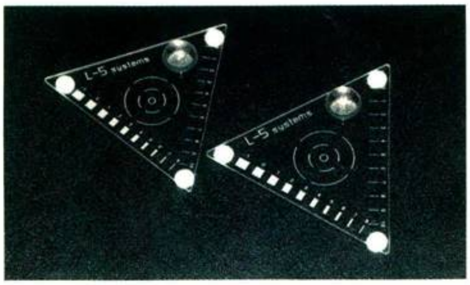

L-5 Systems, 3709 Orion Dr., La Mesa, CA 91941. Desk and field edition scale: $6.95; Deluxe edition scale: $7.95.

New Astronomy Periodical

Reviews of Astronomical Tools is a quarterly English-language journal published in Germany that will contain reviews of astronomical books, CD-ROMs, computer software, and telescopes and accessories.

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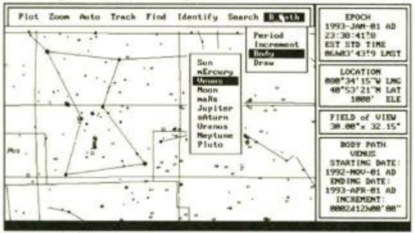

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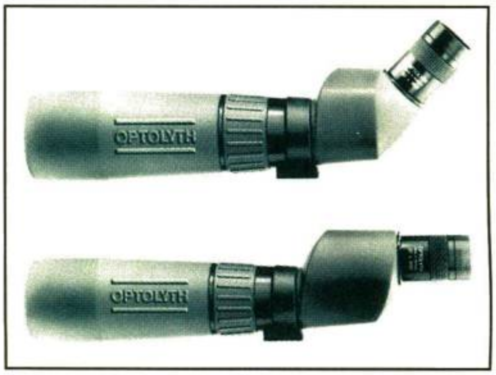

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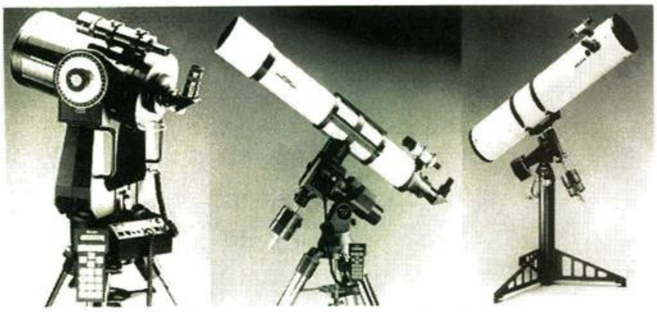

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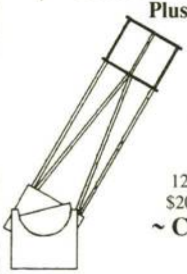

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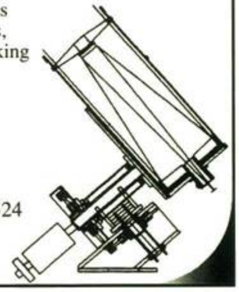

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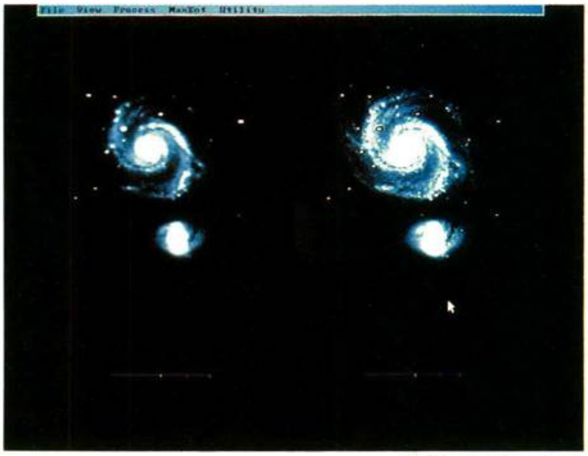

ASTRONOMY: Darla Evans

Hidden Image (version 1.3)
Sehgal Corporation, 1776 Windflower Way, Gloucester, ON K1C 5Y9, Canada, (613) 794-1134. Price: $299 for Lynxx, ST-4, and Electrim CCD camera support; $399 for FITS and ST-6 support. Minimum requirements: 80386-based computer, math coprocessor, 4 MB of memory (8 MB for ST-6 version), hard disk, DOS 3.3, VGA display, and a mouse. Recommended: 80486DX-based computer and SVGA display.

Just as with print and slide versions of astrophotographs, CCD images are occasionally clunkers — the seeing was bad, the stars trailed a bit, or the scope was a tad out of focus. In a darkroom, you would throw the bad ones away. But in the digital darkroom you can transform a poor image into a good one. The touch of magic that makes this possible is called maximum entropy deconvolution.

Maximum entropy attempts to reconstruct the missing information in an image from the rest of the image's information. For example, trailed star images can be transformed into round images because the program knows what the shape of the star should be. Once the program knows how to fix imperfect star images, it can apply the same process to a galaxy or planet in the same frame.

Restoring an image is a slow process because it makes incremental changes to the image. Fast computers with lots of memory help speed the process up (it took three minutes on a 80386 computer with a math coprocessor to do one step of the deconvolution of a 256 by 256 image). Yet the wait is worth the effort because of the results: Good images become stunning ones. Just take a look at Neyle Sollee's image of M51 below to see for yourself. Details barely visible in the original (left) become obvious.

The program will read Electrim, FITS, Lynxx, TIFF, ST-4, -4X, -5, -6, and raw image file formats. You can calibrate the image and adjust the brightness and contrast through automatic brightness stretching, histogram equalization, and nonlinear filters to get rid of dead pixels or bright ones created by cosmic ray hits on the camera. You can smooth and sharpen the image through non-linear filters, unsharp masking, and low- and high-pass filters. The program also lets you square up camera pixels so you can use the image in other programs.

Combining multiple images to make a composite is easy because you can register the images using a star that appears in each frame. Presently you must composite a tricolor image using another program, but you can enhance it with Hidden Image (if the composite is in the TIFF format). A future version of Hidden Image will include tricolor compositing.

A red screen mode lets you use the program at the telescope without ruining your night vision. You don't need to use the keyboard at night because the input windows include an alphabet that you can click on with a mouse.

The manual has several tutorials to help you learn how to use the program and to show you how maximum entropy works. One tutorial steps you through processing the M51 image above. It would be nice if Sehgal Corp. included an index in future editions.

Maximum entropy is a powerful technique that can help you get the most out of your CCD images. It takes some practice to use the method effectively so I wouldn't recommend it to beginning CCD imagers until they master the basics of image calibration. But clearly Hidden Image can take CCD frames and bring out details you never suspected were hiding in them. — *Dave Bruning*

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"Dear Mr. Christen,

The new STARFIRE EDT arrived a few days ago. It was a joy to unpack it and to set it up: it looks beautiful and bears testimony of exquisite craftsmanship throughout. Yesterday the sky cleared up and the telescope got first light. I was out under the stars for many hours — looking, testing and also comparing the new instrument with other telescopes. Yet I soon realized that there was no reason to use any other instrument: the STARFIRE simply was superior. Deep sky views were sharper, cleaner and more contrasty than I have ever seen. And best of all: with this instrument the problem of spurious color definitely is gone — incredible! Jupiter was quite a show at all magnifications I tried. What amazed me was how bright its disc looked even at high magnification, with the colors in the belt system readily visible. There was a wealth of detail, much more than I could have drawn: it was a totally satisfying night of observing. Thanks for a superb instrument."

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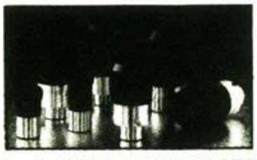

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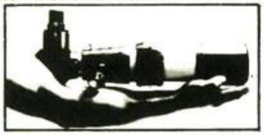

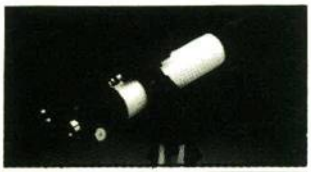

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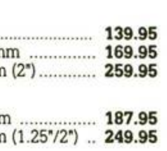

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ASTRONOMY BOOKS

Owning the Night Sky

Beginner's Guide to Amateur Astronomy: An Owner's Manual for the Night Sky

David J. Eicher, (Kalmbach Books, 1993), ISBN 0-913135-18-6, 166 pages, softcover, $19.95.

Eicher presents an easy-to-read book about the basics of astronomy. This book, no doubt, will help usher a new generation into experiencing the universe firsthand. It discusses celestial objects and the tools needed to explore them. You'll learn what you can and can't see, how refracting and reflecting telescopes differ, and what astro-imaging means.

Thirteen chapters describe equipment, the solar system, and deep-sky objects, and glimpse into the future of amateur astronomy. Each chapter is richly illustrated with color and black and white photos, many taken by amateur astronomers. The text clearly explains each topic with a minimum of fuss, which makes the subject easy to understand. My only complaint is that many of the photos appear a page or two away from related text. For example, the chapter on the inner planets opens with images of Venus and text about Mercury. It then closes with photos of Mercury and text about Venus.

I especially like the pictures of people — proud amateurs, famous and not-so-famous — standing beside their homemade and commercial instruments. Eicher presents well the human side of astronomy.

Four appendices provide data about the solar system, a list of the brightest deep-sky objects (Charles Messier's catalog of objects), a list of telescope suppliers, and information about astronomy clubs in North America. Eicher also includes a bibliography of astronomy books for further reading.

A Beginner's Guide to Amateur Astronomy doesn't contain lots of scientific detail. But it's good starter material, rooted in Eicher's years of experience as an amateur astronomer and astronomy writer. If you are starting to learn about our universe, I highly recommend this book. — *Robert Bunge*

The Man Who Sold the Milky Way

David H. Levy, (University of Arizona Press, 1993), ISBN 0-8165-1149-7, 246 pages, acid-free paper, hardcover, $35.

Dutch-born Bart Bok (1906-1983), one of this century's most influential astronomers, finished his graduate studies under the tutelage of Harlow Shapley at Harvard and became a faculty member there, helping to build their radio observatory. After Shapley retired, Bok left Harvard in 1957 to take over the directorship of Mount Stromlo Observatory in Australia. While there, he helped establish the Siding Spring Observatory.

In 1966, Bok returned to the United States to develop the astronomy program at the University of Arizona. The university wanted to take advantage of the opportunities presented by the fledgling Kitt Peak National Observatory, which had its offices just across the street from the university's Steward Observatory. Bok stayed in Tucson until his death, helping to make the university's astronomy program one of the finest in the country.

Bok contributed to in the fields of radio astronomy, the Milky Way Galaxy, and the small dark clouds (Bok globules) that now bear his name. He and his wife Priscilla wrote five editions of *The Milky Way*, which has long been a standard book about our Galaxy. A tireless promoter of astronomy to the general public and a revered teacher, he is sorely missed in the astronomical community. Levy's book is a fine tribute to this man, describing his personal nature, and tracing his achievements at the many observatories where he worked.

Pauper and Prince: Ritchey, Hale, and Big American Telescopes

Donald E. Osterbrock, (University of Arizona Press, 1993), ISBN 0-8165-1199-3, 359 pages, acid-free paper, hardcover, $45.

You know who George Ellery Hale was — the founder of Yerkes, Mount Wilson, and Palomar Observatories. George Willis Ritchey (1864-1945) is less well known, despite his important contributions to those observatories. Osterbrock presents Ritchey's life story, which was intertwined inextricably with Hale's at times. Ritchey and Hale became friends in Chicago in 1890, just a few years before Yerkes Observatory was built. At that time, Ritchey worked as a shop teacher but had a small mirror-grinding lab in his basement. He also helped Hale with optical work at Hale's Kenwood Observatory.

Initially Hale paid Ritchey as his personal optician. Later Ritchey set up the Yerkes optical shop and became its instrument maker. He also took photographs of the Moon with the Yerkes 40-inch refractor that were unsurpassed for many years. Ritchey built Yerkes' 24-inch reflector in 1899.

The death of Hale's father in 1898 freed the young astronomer to move to California and its better night skies. Hale took Ritchey with him and a blank for a 60-inch mirror. Ritchey ground the mirror and designed the telescope for the new Mount Wilson Observatory. In 1910 Henri Chrétien joined the observatory and worked with Ritchey on a new optical design, now called the Ritchey-Chrétien telescope. Although Ritchey hoped to use this design for the new 100-inch Hooker reflector, Hale determined that it should remain of conventional Cassegrain design.

Tensions grew between Ritchey and Hale until Ritchey's impropriety, which included public comments that the 100-inch mirror was hopelessly flawed, forced Hale to fire him in 1919. Hale's action, however justified, effectively banished Ritchey from American astronomy. Ritchey tried to set up his own optical shop but eventually settled at the Paris Observatory in France. He returned to the United States in 1931 and built a 40-inch Ritchey-Chrétien telescope at the Naval Observatory in Washington, D. C. In the late 1930s, Ritchey left Washington and retired to his orange and lemon ranch in California, where he devoted his remaining years to writing.

Visit to a Small Universe

Virginia Trimble, (American Institute of Physics, 1992), ISBN 0-88318-792-2, 336 pages, hardcover, $24.95.

Visit to a Small Universe is a collection of 36 essays written by Trimble from 1963 to 1991. The essays cover ancient astronomy, the lives and deaths of stars, gravitational radiation, and professional astronomy. Trimble includes biographical notes about four astronomers: Martin Rees, Maarten Schmidt, Beatrice Tinsley, and Fritz Zwicky. Essays include "Cheops' Pyramid," "So you want to find a supernova?," "Are galaxies here to stay?," "According to Hoyle," and "Progress is not our most important product."

The Illustrated World of Space

Iain Nicolson, (Simon and Shuster, 1991), ISBN 0-671-77033-0, 64 pages, softcover, $7.95.

Now available in paperback, this fact-filled book provides a marvelous introduction to the science of astronomy for children. It describes the Big Bang, the life cycles of stars, black holes, our solar system, and the planets. A section on space facts provides tables listing the brightest stars, upcoming eclipses of the Sun and Moon, and the sizes of the planets and their satellites. The book includes lots of full-color illustrations throughout. Nicolson explains why we see the constellations the way we do and why stars rise and set, but he doesn't include seasonal star maps to help children learn the constellations. □

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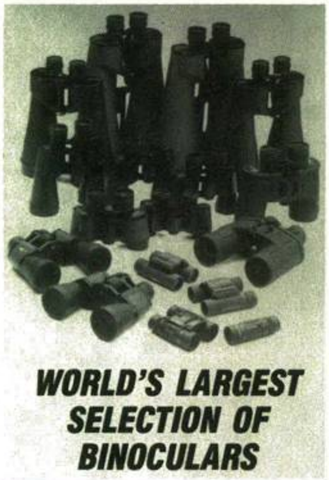

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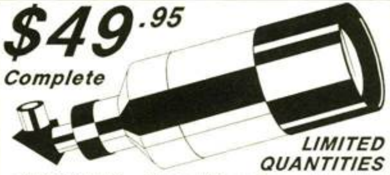

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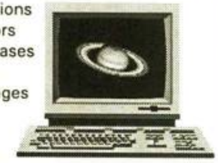

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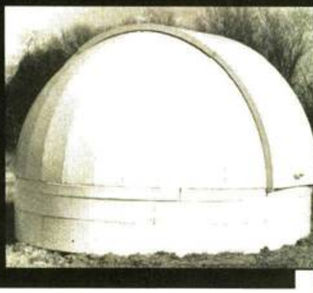

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First Annual Peach State Star Gaze, Future Farmers of America campground outside Covington, Georgia. Sponsored by the Atlanta Astronomy Club. Contact Ken Poshedly, 3440 Everson Bay Court, Snellville, GA 30278, (404) 979-9842.

April 7-10
Mid-South Star Gaze, Rainwater Observatory, French Camp, Mississippi. Contact James Hill, FCA, French Camp, MS 39745, (601) 547-6865 or (601) 547-6970.

April 9
Astronomy Day Program, Montclair Township, Montclair, New Jersey. Contact Valerie Sweatt, Planetarium of the Montclair Public Schools, Glenfield Middle School, 25 Maple Avenue, Montclair, NJ 07042, (201) 509-4274.

April 15-16
Spring Spectacular, Lemon Lake County Park, Crown Point, Indiana. Sponsored by the Calumet Astronomical Society. Contact Stephen J. Miller, Calument Astronomical Society, (219) 845-9174.

April 16
Third Annual Northeast Astronomy Forum & Telescope Show, Holiday Inn (exit 14B on I-97), Suffern, New York. Sponsored by the Rockland Astronomy Club of New York. Contact Don Urban, 73 Haring Street, Closter, NJ 07624, (201) 768-6575.

April 23
Starconn 94, Wesleyan University, Middletown, Connecticut. Sponsored by the Astronomical Society of Greater Hartford. Contact the Astronomical Society of Greater Hartford, P.O. Box 2271, Hartford, CT 06145-2271.

April 30
48th Annual Convention of the North Central Region of the Astronomical League, Burlington, Iowa. Sponsored by the Southeastern Iowa Astronomy Club. Contact Dave or Marion Bachtell, 1901 South 10th Street, Burlington, IA 52601, (319) 753-1442.

May 5-11
1994 South Pacific Star Party, Sydney, Australia. Sponsored by the Astronomical Society of N.S.W. Inc. Contact Treasurer, Astronomical Society of N.S.W. Inc., P.O. Box 1093, Darlinghurst, N.S.W. 2010 Australia.

May 6-8
1994 Southern Star Astronomical Convention, Monroe, North Carolina. Sponsored by the Charlotte Amateur Astronomers Club. Contact George and Mary Chakhtoura, 5023 Walt Gay Road, Monroe, NC 28110, (704) 764-3132.

May 7-8
1994 Convention of the Northeast Region of the Astronomical League, Schenectady, New York. Sponsored by the Albany Area Amateur Astronomers. Contact Sue and Alan French, R. D. 4, Box 205A, Scotia, NY 12302, (518) 374-8460.

May 9-15
Texas Star Party, Prude Ranch, near Fort Davis, Texas. Hosted by the Southwest Region of the Astronomical League. Contact TSP Registrar, 1326 Mistywood Lane, Allen, TX 75002.

May 30
Riverside Telescope Makers Conference, Camp Oaks, near Big Bear Lake, California. Contact RTMC, Fox & Stephens, CPAs, 9045 Haven Avenue, Suite 109, Rancho Cucamonga, CA 91730, (909) 948-2205.

June 4-6
4th Encuentro Nacional de Astronomia, Cali, Valle del Cauca, Colombia, South America. Sponsored by the Asoc. de Astronomos Aficionados, the Grupo Antares de Aficionados a la Astronomia, and the Centro de Estudios Astronomicos. Contact Giovanni Barandica, 923-822624, Luz Marina Duque, 923-581175, or write to ASAFI, 4th Encuentro Nacional de Astronomia, AA 3189, Cali, Colombia, South America.

June 10-11
24th Apollo Rendezvous and Telescope Fair, Dayton, Ohio. Sponsored by the Miami Valley Astronomical Society. Contact Kerry Harman, 2600 DeWeese Parkway, Dayton, OH 45414, (513) 837-4343.

June 25-26
Universe 94, Northern Arizona University, Flagstaff, Arizona. Contact the Astronomical Society of the Pacific, (415) 337-1100. □

Clubs, please submit announcements at least four months before the date of the event. Readers, include a self-addressed, legal-sized envelope with your request for information.

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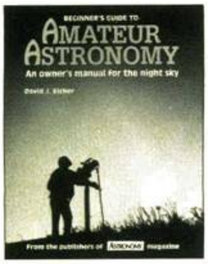
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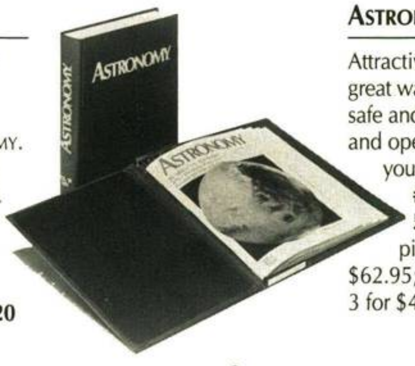

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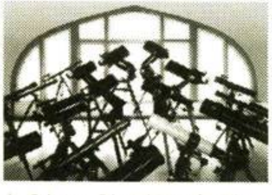

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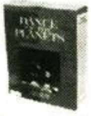

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An Infrared View of our Universe (page 40)

Infinite Vistas: New Tools for Astronomy edited by James Cornell and John Carr, (Scribners, 1985). Somewhat dated now, this book describes the techniques and telescopes used to observe in the infrared.

Hubble Better Than New (page 44)

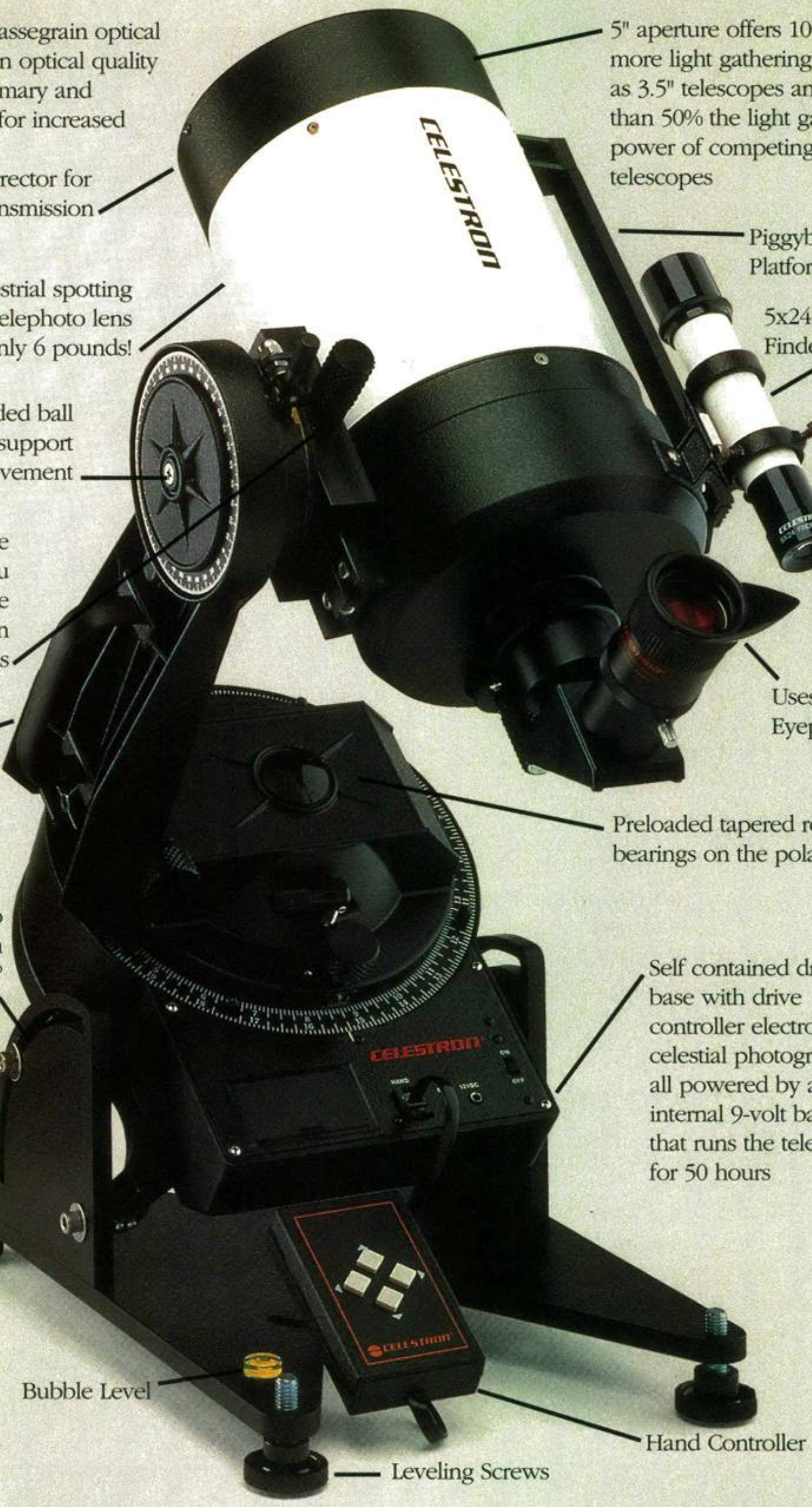
"Putting Hubble Right" by Richard Talcott, ASTRONOMY, March 1994. Describes the shuttle mission that repaired the space telescope.

Jupiter's Magnificent Show (page 74)

"Jove's Hammer" by Robert Burnham, ASTRONOMY, October 1993. Gives a preview of what to expect when Comet Shoemaker-Levy 9 collides with Jupiter this coming July.

Cover: STScI/NASA; **p. 4, left:** NASA/JPL, processed by Mark Robinson; **top:** Ian Gatley, NOAO; **bottom:** Jeff Hester/Arizona State University and NASA; **p. 5:** Kim Zussman; **p. 18, top:** Joseph Harrington/ MIT; **bottom:** NASA/Lockheed/Smithsonian Institution; **p. 20, top:** Gerard A. Luppino/ University of Hawaii; **bottom:** NASA; **p. 22:** Johns Hopkins University Applied Physics Lab; **p. 26:** NASA/JPL from W. Reid Thompson; **p. 28, top:** CARA; **bottom:** NOAO; **pp. 30-31:** NASA/JPL, processed by Mark Robinson; **p. 38:** NASA/JPL; **p. 39, top:** M. Kivelson/ UCLA; **bottom:** NASA/ JPL; **pp. 40-43, infrared:** Ian Gatley, NOAO; **p. 41, top:** Michael Stecker; **p. 42, top:** U. S. Naval Observatory; **bottom right:** Bruce Balick, Univ. of Washington/NOAO; **p. 43, top center:** Jack Marling; **bottom:** Tony and Daphne Hallas; **pp. 44-49:** STScI/ NASA; **pp. 44-45:** J. Hester, Arizona State University/ NASA; **p. 47, top right:** C.R. O'Dell, Rice University/NASA; **p. 52:** L. H. Price, 260mm f/5.6 lens, Fujichrome 400 film, 1-sec. exp., on April 6, 1989; **p. 55:** Joe Liddell, 17.5" f/6 telescope, 3M 1000 film, 15-min. exp.; **p. 57 top:** D. W. Lyon, 8" SCT using eyepiece projection, effective focal length of 32,400mm; **p. 58, bottom:** H. A. Weaver and T. E. Smith/STScI and NASA; **p. 64:** Darla Evans; **p. 65, top and middle:** Donald C. Parker; **bottom:** Stephen Keene; **p. 66, top:** Stephen Keene; **bottom:** C. Capen; **p. 67, top and middle:** Mark J. Coco; **bottom:** Jack Zeiders; **p. 68:** Ken Rubin, 3" f/8 refractor, 30-sec. exp. on Kodacolor 400; **p. 69:** Chuck Vaughan, 8" f/3.8 catadioptric, 8-sec. exp. on Kodak Lumiere 100; **p. 70, left:** David Hanon, 7" f/6 refractor, 1/500-, 1/60-, and 80-sec. exp. on Fuji Velvia, digitally scanned and composited using PhotoStyler; **top three:** Ben Gomes-Casseres, 3" f/7.9 refractor, 30-sec. exp. on Ektachrome 400; **p. 70-71, bottom series:** Don Bowen, 4.5" f/7.9 reflector, 1/500-, 1/250, 1/125-, 1/60-, and 30-sec. exp. on Kodak Gold 400 ; **p. 71, top:** David Silverstein, 175mm f/2.8 to f/8 lens, 1/125 to 120-sec. exp. on Fuji Super HG 400; **p. 72:** Dave Sewell, 8" f/6.3 SCT, 10-sec. exp. on Ektar 1000; **pp. 72-73, top:** Jeffrey Pettitt, 28mm f/2.8 lens, 120-sec. exp. on Kodak Gold Plus 400; **p. 73, top right:** David J. Pontzer, 135mm f/2.8 lens, 300-sec. exp. on Fuji H400; **middle:** Jerry Schad, 85mm f/2 lens, 30-sec. exp. on Ektachrome P1600; **bottom:** Don Trombino; 6" f/6 refractor, 10-sec. exp. on Ektachrome 200; **pp. 74-77:** Jean Dragesco; **pp. 78-79:** José Olivarez; **p. 80:** Jack Newton; **p. 81:** Bill and Sally Fletcher; **p. 82, top:** Kim Zussman; **middle:** Preston S. Justis; **bottom:** Jack Newton; **p. 83:** Jack Newton; **p. 87, top:** Ernie Piini, 90mm Maksutov-Cassegrain, Kodacolor 200 film, 1/250-sec. exp. with ND-4 solar filter on November 6, 1993, from Canberra, Australia; **bottom:** James Kevin Ty, 80mm Maksutov-Cassegrain, Velvia 50 film, 1/1000-sec. exp. with ND-4 solar filter on November 6, 1993, from Manila, Philippines; **p. 88, top left:** Luke Dodd, 4.7" f/8.5 refractor, hypersensitzed Fuji 400 film, 60-min. exp.; **top right:** James R. Foster, 11" SCT at f/6.3, hypersensitized Tech Pan film, 95-min. exp.; **middle right:** Andrew Peters, 20" f/5 reflector, hypersensitzed Fuji 400 film, 13-min. exp.; **bottom left:** Brad D. Wallis and Robert W. Provin, 4" f/8 refractor, hypersensitized Tech Pan film, 120-min. exp.; **p. 89:** George Greaney, 6" f/7.1 refractor, hypersensitized Fuji Super HG 400 film, composite of two 30-min. exp. printed on Vericolor film; **p. 90, top left:** Bob Yen, 165mm lens, Pentax 6x7 camera, Ektachrome 400 film, 16-min. exp. on November 28, 1993 (starting at 10:20 p.m. PST), from Anza-Borrego State Park, California; **top right:** Chris Cook, 8" SCT at f/6, ScotchChrome 400 film pushed to ISO 800, 30-min. exp. on November 13, 1993; **middle:** David E. Thomas, video camcorder image rephotographed onto slide film; **bottom left:** James R. Foster and Michael A. Stecker, 14" SCT at f/7, tricolor composite of three filtered exp. on hypersensitized Tech Pan film: 180-min. exp. (Wratten #25 red filter), 95-min. exp. (Wratten #11 yellow-green filter), and 222-min. exp. (Wratten #47A blue filter); **pp. 90-91:** George Livadaras, 55mm lens at f/2.8, Kodachrome 64 film, taken on November 18, 1993; **p. 90, bottom:** George Greaney, 6" f/7.1 EDF refractor, composite of two 60-min. exp. on hypersensitized Fuji Super HG 400 film printed onto Vericolor print film; **p. 98:** Darla Evans; **p. 113:** Bruce Balick, UW/NOAO. □

THE CELESTRON C5^{+}...



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C5 tube doubles as terrestrial spotting scope or a 1250mm f/10 telephoto lens – tube weighs only 6 pounds!

Two preloaded ball bearings for rigid support with smooth movement

Quick release mechanism allows you to remove the telescope from the fork tine in seconds with no tools

Convenient carrying handle

Heavy-duty table top wedge adjustable from 0° to 90°

5" aperture offers 100% more light gathering power as 3.5" telescopes and more than 50% the light gathering power of competing 4" telescopes

Piggyback Platform

5x24 Finderscope

Uses 1-1/4" Eyepieces

Preloaded tapered roller bearings on the polar axle

Self contained drive base with drive controller electronics for celestial photography – all powered by a single internal 9-volt battery that runs the telescope for 50 hours

Numerous accessories available for visual and photographic purposes

Compact 9"x20"x20" system allows you to take it virtually anywhere, from your backyard to a remote observing site – weights just 23 pounds, wedge included!

Bubble Level

Hand Controller

Leveling Screws

For a brochure contact your local Celestron dealer or Celestron International directly

... Everything You Want in a Telescope

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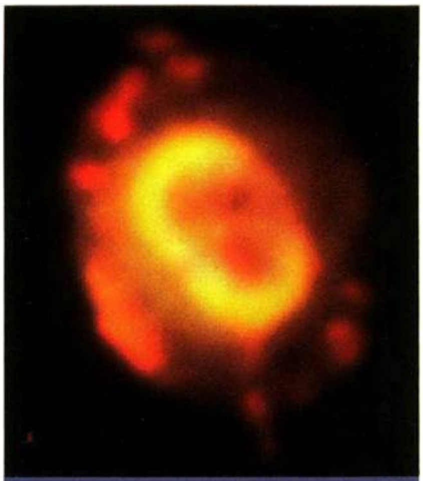
EXPERIENCE



Bruce Balick, UW/NOAO

COMING IN THE MAY 1994 ISSUE OF ASTRONOMY

STELLAR DEATH RATTLES New research on planetary nebulae shows that stars do not go gentle into that good night.

CLICK . . . WHIR . . . WHIR . . . BEEP . . . Astronomy software has grown highly sophisticated and complicated. Our survey cuts through the jargon to help you decide what programs you really need.

RETURN TO THE MOON Humans left the Moon over 20 years ago. What are the chances we will ever return?

THE UNITED STATES IN ECLIPSE Here's your complete guide to observing the May 10 annular eclipse that cuts across North America.

AVAILABLE ON YOUR NEWSSTAND

APRIL 12

ASTRONOMY MAGAZINE REVIEWS GENESIS-SDF

Excerpts from Alan Dyer's review in the January '94 issue:

"The newest version of Tele Vue's Genesis refractor offers first-class optics in a convenient and highly portable package...

NEW! 27mm 15mm PANOPTICS IN STOCK

Bermuda '94

Cruise with the Rockland, NY Astronomy Club 8/28 - 9/4/94. Call Bob Slone, Global Tours, 800-770-2929 before 3/5/94

...On critical star tests, the Genesis-sdf performed flawlessly. Both pairs of the double-double star Epsilon Lyrae appeared cleanly split with dark sky between the tiny, sharply defined stars. Saturn was sharp and contrasty, with the Cassini division in the rings as well as color differences in the belts and zones on the planet's disk clearly visible.

The level of color correction in the SDF was impressive. The edge of the Moon was pure white. Saturn appeared without any trace of a blue halo. The zero magnitude star Vega, one of the toughest tests, showed the merest hint of a blue halo that came and went with seeing conditions. This is a superb level of color correction in any refractor, let alone one this fast and portable.

The flat field was apparent when scanning star field with Tele Vue's 35mm Panoptic eyepiece, itself optimized to provide a wide, flat field.

Combined with premium wide-angle eyepieces, this is a telescope capable of providing stunning low-power views of Milky Way starfields. And yet under good seeing conditions, the sharp optics will easily handle 200 to 250 power for crisp lunar and planetary views.

Genesis serves as a superb deep-sky astrophoto scope. Test shots on 35mm film of starfields in Cygnus exhibited sharp star images corner to corner across a 4° field.

The rack-and-pinion focuser operated smoothly with no backlash or image shift. The focuser accommodates 2-inch accessories and has a screw for tightening the tension. The focuser did not slip even with heavy cameras or eyepieces attached.

I tested the Genesis on Tele Vue's alt-azimuth mount, the Gibraltar, a well-crafted mount made of machined and black-anodized aluminum. The wood tripod is made of ash. The mount has smooth Dobsonian-like motions, making it easy to nudge this scope every few moments to recenter the image.

Tele Vue offers a finder called the Starbeam. When you look through this nifty device, you see a red dot projected against the naked-eye sky. The dot shows you exactly where the scope is pointed.

I also checked out Tele Vue's new Air-Chair seat, a sturdy, well-padded stool with a handy pneumatic height adjustment. Whether you are looking at the horizon or at the zenith, you can remain comfortably seated without the need to stretch or crouch, a convenience that adds immeasurably to the pleasure of using this telescope.

In all, I found the package well engineered and friendly to use. If a portable, high-performance, and beautifully finished instrument is what you are seeking in an astronomical telescope, the Genesis-sdf is an excellent choice."

TELE VUE REFRACTORS

Genesis-SDF: 4 inch, Special Dispersion lenses + Fluorite, 4-element, Flat-Field, 540mm, f/5.4

Unforgettable Images.
Genesis-SDF
Renaissance-SDF
Pronto

Unforgettable images...both rich-field & diffraction limited...pride of owning a fine piece of American craftsmanship...convenience; These unsolicited sentiments plus those below have been shared with us by so many Tele Vue telescope owners. Our goal is to produce scopes so rich in value, that you may enjoy exploring all facets of your Universe. Call a Tele Vue dealer today to begin your unforgettable journey.

Pronto: 70mm, E.D. Doublet, 480mm, f/6.8

No picture or description prepared me for the beauty of the design or the excellence of the workmanship. J.T. - RI

The detail it shows on Jupiter is absolutely unbelievable. B.D. - CO

I was able to see Jovian lunar shadow transit easily with this instrument. I love the design and features - I may have to buy a Genesis! R.G. - PA

It's almost as if I'm not using a scope at all. Too many scopes just get in the way and make observing a frustrating experience. T.Z. - NY

Wanted a first telescope with superior optics, portability and value. I got what I asked for, wonderful little thing. J.P. - U.K.

Well done! Saw the Owl and M108 in same field. T.J. - KS

The Genesis-sdf, 20mm Nagler Type 2, and Gibraltar mount combination is a game breaking touchdown! G.B. - NJ

Compact, easy to carry & solid case. Delivers one of the best, false-colour-free images I've ever seen in this size & aperture! Thank you. B.D. - Germany

WOW! Easily split Nu Scorpii and Antares! Jupiter looks great ! D.S. OH

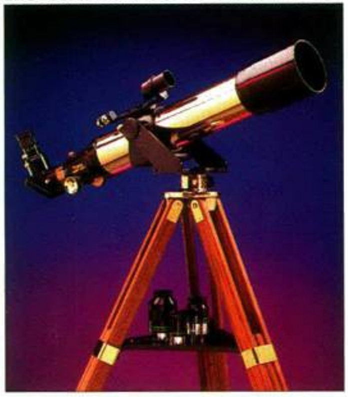
I am greatly satisfied with the quality of craftsmanship that was put into this fine instrument. M.H. - PA

Fantastic! Sharp views of planets, moon and star fields...excellent high power results!! J.C. NJ

It's the only scope I recommend to friends. B.H. - KS

Superb optics! Sharpest images of any scope I've ever owned. Pinpoint star images. R.M. MD

Renaissance-SDF: Solid Brass



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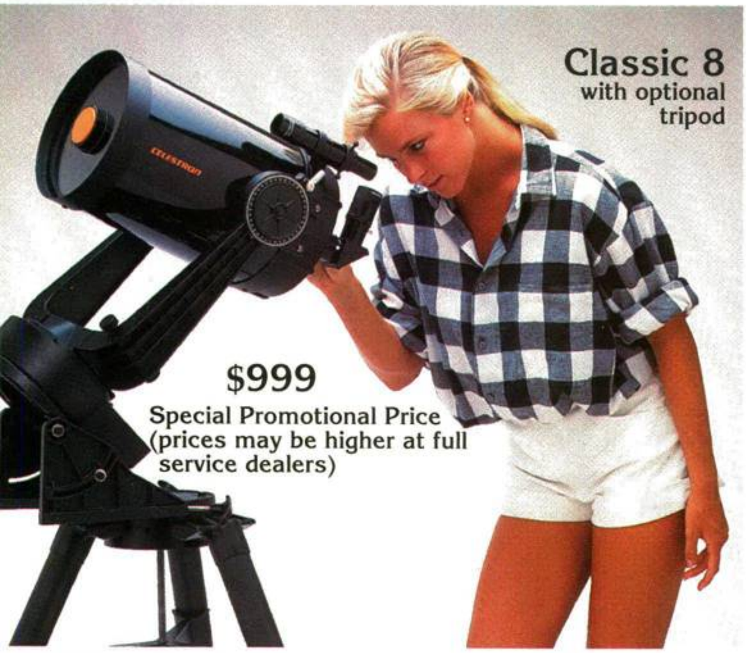


Classic 8
with optional tripod

$999
Special Promotional Price
(prices may be higher at full service dealers)

Two Celestron 8″ f/10 Schmidt-Cassegrain telescopes at incredible savings. Both models have the same unsurpassed optical system — consistently superior images with the standard Starbright® coatings, fine optical crown glass corrector along with the best baffling system to ensure the highest transmission as well as the best contrast.

The Classic 8 is for the casual observer. It runs off of AC power and comes with a 6x30 finderscope, 25mm MC Kellner eyepiece, star diagonal and wedge.

The Ultima 8 is for the more serious astrophotograper and observer who seeks the finest Schmidt-Cassegrain optics along with the utmost in rigidity and the most accurate drive system. The drive operates off a single 9-volt battery! This telescope comes with a 7x50 finderscope, 26mm Plössl eyepiece, star diagonal, wedge, tripod and case.

Freight charges — $75 for either model.

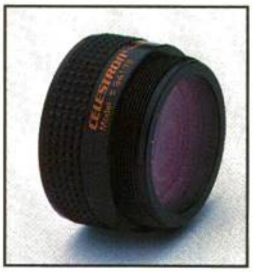
$1799
Special Promotional Price
(prices may be higher at full service dealers)

Ultima® 8
with optional finderscope

FREE $200 VALUE

Purchase either telescope from February 1 through March 31, 1994 and receive a **free 2x Barlow Lens** (#93510) – 2 ¾″ length, fully multi-coated AND a **free Plössl eyepiece** – 1 ¼″, your choice of a 7.5mm (271x), 10mm (203x), or 17mm (120x). Just send your proof of purchase to the Celestron customer service department.

SAVINGS SAVINGS



The Celestron Reducer/Corrector f/6.3 is one of the most useful accessories for visual and photographic use for Celestron Schmidt-Cassegrains. It is a four element design and **fully** multi-coated. This proven design is unsurpassed in performance and during the month of March it is available at participating dealers for the reduced price of $125!

ADD THE OPTIONAL ADVANCED ASTRO MASTER® TO COMPUTER CONTROL EITHER TELESCOPE.

1 ¼″ Plössl Eyepieces

NEW *PLÖSSL EYEPIECES*

Plössl eyepieces are now available at affordable prices. All units are **multi-coated** for enhanced contrast. A complete series of **both .96″** and **1 ¼″** sizes are offered. Celestron is the first to offer .96″ eyepieces of superior design.

FOCAL LENGTH	FIELD OF VIEW	EYE RELIEF	SIZES
7.5 mm	52°	5mm	.96″, 1 ¼″
10mm	52°	6.5mm	.96″, 1 ¼″
17mm	52°	13mm	.96″, 1 ¼″
26mm	50°	22mm	.96″, 1 ¼″
40mm	46°	31mm	1 ¼″

NEW *200mm (7.9″) f/4 NEWTONIAN TELESCOPE*

An incredibly fast f/4 Newtonian with superb optical quality. The focal length of 800mm is packed in a tube that weighs just 13 pounds and is 28 inches long. The mirrors are multi-coated. The optical tube is mounted on the highly touted GP mount. The standard accessories include a 6x30 finderscope and 12mm ocular.

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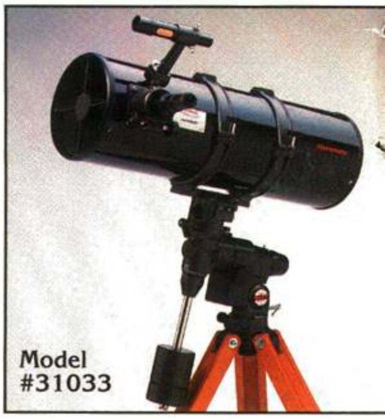

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